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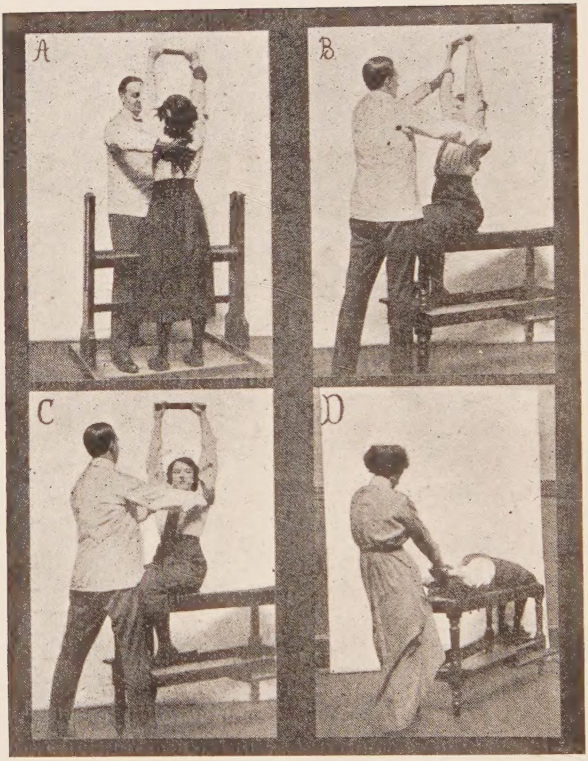

FIG. 30.—RESISTANCE EXERCISES FOR STRENGTHENING THE SPINAL MUSCLES.

A. Standing, thighs opposite bar: trunk flexion, patient resisting; trunk extension, surgeon resisting.
B. Sitting astride: trunk flexion, etc., as in A.
C. Sitting astride: trunk twisting, surgeon resisting.
D. Lying: arm extension, patient resisting: arm flexion, assistant resisting.

ORTHOPÆDICS FOR PRACTITIONERS

AN INTRODUCTION TO THE PRACTICAL TREATMENT OF THE COMMONER DEFORMITIES

BY

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PREFACE

In this book the object of the author has been to give a clear account of the successful treatment of the commoner deformities likely to be met with in everyday practice, no attempt having been made to include all known deformities. It sets forth his present views, which have been adopted gradually as the result of experience. Many of them were first presented clearly, if not indeed originated, by Thomas of Liverpool, and to his genius modern orthopædic surgery owes a tremendous debt. Others who have largely influenced him are: his father, Bernard Roth, whose pioneer work on lateral curvature will always remain the object of his sincerest admiration; Lucas-Championnière, who devised a common-sense treatment of fractures by mobilisation and massage; Rollier of Leysin, who first showed the immense benefits resulting from heliotherapy; and Arbuthnot Lane, whose teaching as to the correct alignment of displaced bones and whose operative technique, once mastered, can never be forgotten.

Here and there use has been made of the plans of other men, but much that has been made a trial of has later been discarded. On the other hand, if one is to progress one must be ever ready to give up old, even favourite, methods and make use of new ones should they prove to be better.

Thus it will be noticed that the use of plaster of Paris bandages is advised but seldom. Though formerly in favour of plaster, the author has since found that it possesses many disadvantages and that an appliance often does its work much better, and so never uses it now except when forced to—*e.g.*, where it is necessary to fix a limb in a certain position, and no apparatus is available.

P. B. R.

Harley Street, W.
March, 1920.

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ORTHOPÆDICS FOR PRACTITIONERS

CHAPTER I

DEFORMITIES PRESENT BEFORE BIRTH

1. Congenital Club-Foot.

There are several varieties of this condition, and it will be necessary, before discussing them, to describe the terminology employed. Thus, all are cases of "talipes"—club-foot; while if the heel is drawn up through contraction of the tendo Achillis, the condition is denoted by the addition of the adjective "equinus"—thus, "talipes equinus." If the tendo Achillis is much stretched and the foot dorsiflexed, the adjective "calcaneus" is employed—thus, "talipes calcaneus." Then, again, if the foot is twisted so that the sole looks inwards (inversion), the inner border of the foot being raised, the term "varus" is employed—thus, "talipes equino-varus," and "talipes calcaneo-varus"; and if the foot is twisted so that the sole looks outwards (eversion), the outer border of the foot being raised, the term "valgus" is used—thus, "talipes equino-valgus," "talipes calcaneo-valgus"; and, finally, the eversion may be accompanied by a hollowing or exaggeration of the arch of the foot, denoted by use of the word "cavus"—thus, "talipes equino-cavo-valgus," "talipes calcaneo-cavo-valgus."*

* The same deformities, with the same names, occur as a result of infantile paralysis; they are distinguished from the congenital varieties by the use of the term "paralytic"—thus, "paralytic talipes calcaneo-valgus."

By far the commonest variety is talipes equino-varus, in which the heel is drawn up, and the foot twisted in (inverted). In addition, the muscles of the affected limb are imperfectly developed, and the twist of the foot is accompanied by a twist of the whole limb.

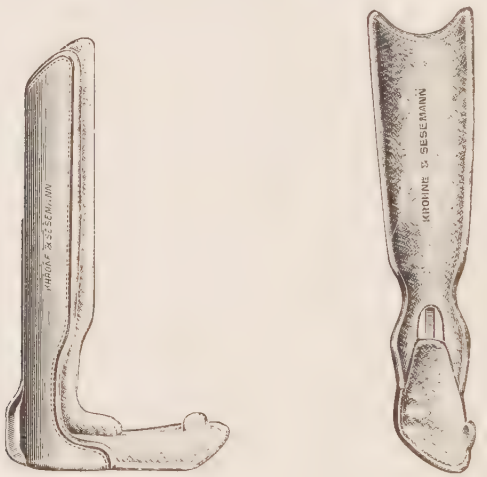
The causation of this condition is not known; increased intra-uterine pressure, scarcity of the amniotic fluid, arrested development, harmful maternal impressions, each in turn has been brought forward as the cause of the trouble, but we are no nearer the truth.

The treatment of a case of talipes equino-varus, if seen early, is simple in the extreme, and should begin within three weeks of birth. It must be explained to the parents that what you are aiming at is to get a foot which can be put flat to the ground, and with which the patient can walk. The foot will be serviceable, but it will probably be broader and shorter than the sound one, and the imperfectly developed muscles of the leg will never be able to catch up with the normal muscles of the unaffected limb. The deformity of the foot consists of two parts, the equinus and the varus, and it is the latter which must be dealt with first. The foot has got to be forcibly untwisted by splint and manipulations until all the tendency to twist has gone and the foot will lie perfectly straight in the equinus position. This usually takes from six to nine months; at the end of nine months the equinus deformity is dealt with by lengthening the contracted tendo Achillis, and a straight foot results. No greater mistake can be made than to operate on the tendon before the inward twist of the foot has been entirely obliterated, for the contracted state of the tendon, by fixing the foot, makes it so much easier to exert force on the tightened structures of the inner border of the foot in order to stretch them and undo the twist; in fact, until the twist is undone, the contraction of the tendon is a tremendous advantage.

The twist is undone (1) by bandaging the foot to a small straight splint, applied to the outer side of the leg, ankle, and foot, which is only removed once in the twenty-four

hours to allow the child to be bathed; and (2) by manipulating the foot for ten minutes daily after the bath. The splint is one of malleable iron (7 inches $\times$ $1\frac{3}{4}$ inches), padded on one side, and covered with fine mackintosh: it is applied straight to the outside of the leg, ankle, and foot, which forms a convex surface: the lower end is secured to the foot first with a few turns of bandage, the upper end projecting upwards with an interval between it and the outer surface of the leg. The foot is then forcibly untwisted into the straight position until the upper end of the splint comes to lie against the outer surface of the leg, to which it is fixed with several turns of bandage, the foot remaining in the equinus position. At first the foot can only be untwisted with difficulty; but after four or five weeks this becomes easy, and little force is necessary. It is then time to increase the effect by bending the splint into a crescent, and applying its convex surface to the convex surface formed by the leg, ankle, and foot, it being bandaged on in the same way as before. This has the effect of overcorrecting the twist, and after being employed for many months can be dispensed with, leaving the foot lying perfectly straight. Thus we are introduced at the outset to one of the guiding principles of orthopædics, **"overcorrection,"** which consists in overcorrecting a deformity temporarily in order that it may remain corrected permanently. This simple splint is used in conjunction with manipulations carried out daily for ten minutes after the bath and before the splint is reapplied. The foot lying on its outer side, the nurse or mother takes it in her two hands, her two thumbs being placed together beneath the outer side, and, using them as a fulcrum, she forcibly untwists or uncurls the foot repeatedly, using all the strength she dares short of making the child cry. After ten minutes she powders the foot well and reapplies the splint, using a 2-inch bandage of unbleached linen. Day after day this treatment is carried out until after, say, nine months the foot lies perfectly straight when the splint is removed, and the time has come for the child to be made ready for walking

by lengthening the tendo Achillis. It is a mistake to divide it earlier even if the varus deformity has been got rid of; you do not want to divide it until the child is nearly able to stand, for the standing will assist to prevent the deformity from recurring. If you divide it at six months, you have very little power of leverage left over the varus twist, which is liable to recur if no standing or walking is done. Before lengthening the tendon a splint, known as a "right-angled tin night-shoe" (Fig. 1), must be obtained



a *b*

FIG. 1.—RIGHT-ANGLED TIN NIGHT-SHOE.
a, Side view; *b*, front view.

in which to bandage the foot after operation, and in which it will be kept at night for years to come. This consists of a leg-piece shaped like a gutter, and a flat foot-piece set at right angles to it; there is a small vertical plate rising up from the inner side of the foot-piece for the big toe to rest against, and part of the gutter-like leg-piece is cut away to allow for the heel. The whole is well padded, and covered with chamois-leather. (This splint is of great use in the treatment of numerous other deformities.)

The operation of lengthening the tendon is performed

under a general anæsthetic. The child lies prone, with the foot projecting over the end of the table. With a sharp-pointed tenotome the skin is punctured in the mid-line, where it lies over the upper part of the tendon, the blade being parallel with the fibres of the latter; the tenotome, having been pushed in until the tendon is transfixed, is now turned at right angles to its fibres, say to the right, and made to cut its way directly out, the right half of the tendon being thus divided at this level. The tenotome is now withdrawn, and a fresh puncture made 1 inch lower down on the tendon nearer the heel; it is transfixed as before, the tenotome turned at right angles, this time to the left, and made to cut its way out, the left half of the tendon being cut at this level. On forcibly dorsiflexing the foot, the cut fibres separate and the tendon elongates. The advantage of this procedure over simple tenotomy is that no complete gap is left between the divided portions, a gap which might fill with imperfect and easily stretchable material. (This can be done through a single open incision, when it is known as the Z operation; but the subcutaneous method is much simpler.) When the operation is done, a flat pad of gauze is applied over the back of the heel and lower third of the leg, and the foot firmly bandaged into the tin night-shoe at right-angles to the leg. There it is kept for a week, when it is taken out and a bath allowed. It is then replaced, and kept there for another week, after which it is taken out twice daily, and the same manipulations carried out regularly as were used before the operation. As soon as the child begins to stand, it is allowed to do so in the splint; when it can actually stand alone or get about round the furniture, it is time to remove the splint for a few hours daily, and allow the child to wear ordinary little boots. The surgeon must observe if there is still any tendency to varus; if there is, he must counteract it when the child is standing and walking by having a $\frac{1}{4}$-inch varus wedge added to the outer side of the sole and heel of the boot so as to evert the foot; and when the child is resting in the splint, by having the sole plate of the night-

shoe everted 15 degrees. As soon as the child walks alone a tendency will be noticed to rotate in the leg and foot at the hip; this is because the deformity of club-foot is only part of a general twisting in of the whole limb. This tendency is to be overcome by **education,** not by heavy and expensive appliances stretching up to the waist, so beloved of orthopædic hospitals. The mother and nurse are daily to teach the child to walk with its "toes turned out." By the time it is three and a half or four years old it will do this without any difficulty. Concurrently with this education the child is made to do little exercises with the foot against the resistance of the nurse for a few minutes every day. These are

Plantar flexion, child resisting.	Eversion, child resisting.
Dorsiflexion, nurse resisting.	Inversion, nurse resisting.
Plantar flexion, nurse resisting.	Eversion, nurse resisting.
Dorsiflexion, child resisting.	Inversion, child resisting.

Every three months the child should be brought to see the surgeon, who will examine the foot, suggest alterations in the wedging of the boots and in the tilting of the sole-piece of the night-shoe, will see the exercises and manipulations are being carried out to his satisfaction, and observe the child's gait. If the parents and nurse loyally carry out the surgeon's advice and directions, and visit him frequently, they will be rewarded by seeing their child's foot become more and more like the normal one. Supervision and treatment on these lines will be required until adolescence is reached.

Remarks.—Now and then a severe case may be met with where, on lengthening the tendon, it is not possible to bring down the heel completely all at once and place it snugly in the night-shoe. In such a case, a week after the operation a second anæsthetic must be given, and the foot forcibly wrenched with the hands into a good position, and retained there in plaster of Paris bandages. The plaster is removed in two weeks, when the foot will lie properly in the splint, and the treatment can be proceeded with.

The tenotome used should have a blade $\frac{1}{3}$ inch in length, with a long slender neck (Fig. 2); a fresh tenotome should be used for the second puncture. In dressing the foot immediately after the operation one should be careful not to press in the skin against the cut tendon; if this be done, there is a chance of the skin becoming adherent to it; so a large flat pad of gauze must be used, with firm but not tight bandaging. The sole-piece of the night-shoe may be everted by the instrument maker, or one can do it oneself by introducing a thin wedge-shaped layer of wood beneath the foot, with the base of the wedge to the outer side.

FIG. 2.—TENOTOME FOR PERFORMING TENDON LENGTHENING OF TENDO ACHILLIS IN A CHILD, AND FOR DIVIDING CONTRACTED EXTENSOR TENDONS OF THE TOES.

Note the shortness of its blade.

Treatment of Other Varieties.—This will be carried out on similar lines. Where there is simple equinus, the tendon will require to be lengthened just before the child is ready to walk. Where there is valgus, the straight splint will be applied to the *inner* border of the leg, ankle, and foot, and the sole-piece of the night-shoe will be inverted. Where there is calcaneus, the shortened anterior tendons will eventually yield to manipulation, no tendon-lengthening operation being necessary, and the sole-plate of the night-shoe will require setting on to the leg-piece at an obtuse angle of 120 degrees, transforming it into an obtuse-angled tin night-shoe (Fig. 3). In the calcaneus deformity it may be noted there is not so much a shortening of the anterior tendons as there is a *lengthening* of the tendo Achillis; and one's efforts must be directed largely to getting this to shorten by keeping it constantly relaxed.

Treatment of Neglected Cases.—These consist of cases which have been properly treated in the first place and then

allowed to relapse; and of others which have never been treated at all. The foot is twisted round in a case, say, of talipes equino-varus so that the sole looks directly inwards instead of downwards; the heel is drawn up; the patient walks on the outer border of the foot, where a callosity develops, and sometimes the outer malleolus actually touches the ground. In such a condition, manipulations and tendon lengthening and wrenchings alone are powerless to bring about anything like a good result, for the astragalus has become deformed, bent on itself, and prevents any reduction of the deformity. A wedge of bone, with its base outwards, must be chiselled out of the astragalus and the foot wrenched back into position and put up in plaster for several months. In conclusion, I am utterly opposed to the treatment of these cases by walking instruments (braces) and T straps; I have seen a great deal of it, and I know how useless it all is. Especially would I condemn the use of a walking instrument with pelvic bands to counteract the tendency of the limb to rotate inwards; it is frightfully heavy, it only partially undoes the twist, and as it never calls for voluntary effort on the part of the patient, his power of outwardly rotating the limb is still further lessened.

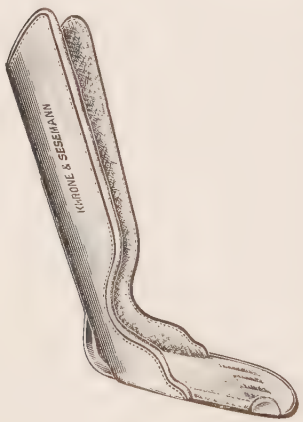


FIG. 3.—OBTUSE ANGLED NIGHT-SHOE.

2. Congenital Dislocation of the Hip-Joint.

This may be single or double. The cause, as in the case of congenital club-foot, has been ascribed to malposition *in utero*, and to increased intra-uterine pressure. It is usually not diagnosed until the child begins to walk, and this has led to the suggestion that the dislocation is not

really present at birth, but only takes place on the assumption of the upright posture from some abnormal relaxation of the joint capsule. That this is not the case is proved by the fact that both the acetabulum and the head of the femur are imperfectly formed, the former being shallower and the latter more flattened than normal, changes due to the prolonged lack of interaction between the acetabulum and the head of the bone.

The dislocation is almost invariably backwards, with the head of the femur lying on the dorsum ilii; the head may be touching the acetabular margin, or separated inches from it. Owing to this backward displacement the child, in order to maintain the erect posture in standing, has to carry the upper part of the trunk farther back, thus producing an exaggerated lordosis in the lumbar region. There is commonly some deformity of the neck of the bone, consisting of curvature, with convexity forwards.

Signs.—The mother brings the child to the surgeon, stating that it has never walked like other children. On examination it walks with a waddling duck-like gait, especially pronounced if the dislocation be bilateral. On observing it stripped and standing, there is the lordosis just mentioned; on palpating the hip when it is lying supine on a couch, the great trochanter of the affected side will be found "raised" level with, or even above, the anterior superior iliac spine; and the head of the bone will be felt lying on the back of the ilium. Other signs of interest are: shortening of the affected limb; a lack of fullness in front where the head ought to be; increased range of adduction, with a correspondingly decreased range of abduction; and the telescopic test—when the trunk is fixed by an assistant it is possible to alternately shorten and lengthen the limb by pushing or pulling it, the head of the bone sliding up and down on the back of the ilium. A radiogram shows the head of the bone out of the acetabulum; the head is flattened and the acetabulum shallow.

Diagnosis.—The one condition with which it can be readily confused is coxa vara, due to separation of the

upper epiphysis of the femur (Fig. 39); but in this, which occurs in older children, there is usually pain; there is a limp, but no waddling gait; the head of the bone is not displaced; the telescopic test is negative; and the radiogram at once reveals the true state of affairs.

It may also be mistaken for tuberculosis of the hip-joint, but the pain, wasting, and limitation of movement present in this disease, and the radiogram, should prevent any difficulty.

Treatment.—The dislocation must be reduced. This is done under an anæsthetic very much according to the method known as the "bloodless reduction" of Lorenz. The best time to do this is as soon as the child is able to walk—*i.e.*, in most cases as soon as the condition is diagnosed. If it be diagnosed earlier, and the reduction performed, there may be some difficulty in teaching the child to walk with the thigh in the position of flexion and abduction so essential for treatment.

If, on the other hand, the child be brought for treatment years later, it is possible to reduce the dislocation; but with each year after the first two or three it becomes increasingly difficult, and after seven or eight one is not likely to have a success. It should be noted that not every case below the age of eight can be reduced, but only the large majority of cases; and some of these only after two or three attempts. In embarking on a case, therefore, the parents must be warned of the possibility of failure.

The chief difficulty to overcome in the actual reduction is the shortening of the hamstrings and glutei behind, and of the adductors in front. The chief difficulty after the reduction is in preventing the dislocation from recurring, for the acetabulum is shallow and the femoral head flat.

Operation of Reduction.—With the child lying supine under an anæsthetic, the hamstrings, glutei, and posterior part of the capsule are stretched first by flexing the thigh with the knee extended. The limb, with the knee kept straight, is alternately raised from the table (flexed) as far as it will go, and then lowered (extended); then raised,

then lowered, and so on. Each time the limb is raised a little ground is gained, and the thigh can be flexed a little farther than before. This is worked at for five or ten minutes until it becomes possible to bring the thigh, still with straight knee, in contact with the abdomen. The structures behind are now sufficiently stretched, and those in front, the adductors, must be attended to. In Lorenz's method the thigh was forcibly abducted, and the tightened adductor muscles were pounded with the heel of the hand until their insertions into the pubic bone gave way, and no tight bands were visible beneath the skin even when the limb was abducted to the full amount. This was followed by much ecchymosis and bruising of the parts, and to an observer seemed far from ideal. Quite frequently the skin would be broken, and all claim to calling the method " bloodless " vanished. It is far better to introduce a tenotome and divide all tight bands subcutaneously, sealing the puncture with collodion, the limb being alternately abducted and adducted until full range of abduction is obtained, which is reached when the thigh can be abducted 90 degrees while at the same time it is flexed 90 degrees.

The soft parts are now in a condition to allow for reduction, which is carried out by flexing the thigh to 90 degrees (this brings the head of the bone down level with the acetabulum), then abducting 90 degrees (this brings the head close to the acetabular margin), and then levering the head over the lower and posterior lip into the socket itself. You stand on the left side of the child in the case of a left dislocation, an assistant standing well over the child to fix the pelvis by forcibly holding it down with his hands, one being placed over each anterior superior spine. You grasp the knee in the left hand, and placing the back of your right wrist beneath the child's buttock to act as a fulcrum, you try to lever the head forward over the edge of the acetabular lip, using all the force you dare. After several trials, maybe, the assistant pressing down the pelvis to the table all the time, a sudden click or scrunch is felt and heard, and the limb becomes fixed or locked in an

unmistakable manner, and you know that the dislocation is reduced. If you now try to straighten (extend) the thigh, the dislocation will recur, so don't attempt it. (Some operators, after reducing the dislocation, seem unable to resist producing it again and reducing it repeatedly; they call this "making sure they have really reduced it." But one reduction only is necessary, and each successive redislocation and reduction causes injury to the capsule and increases the likelihood of recurrence later.)

Having got the dislocation reduced, the thigh must be kept in plaster in the flexed and abducted position, the "first position," for at least six months. As there may be considerable swelling and bruising of the parts for the first few days it is advisable not to apply the plaster right away, but to wait a week for this to subside, in the meantime bandaging *both* thighs in the "first position," or as near it as possible, to a broad flat splint placed horizontally across the back of the child's sacrum. Then, after a week, a radiogram having been taken showing the dislocation reduced, the splint is removed, and a hip plaster applied to the affected side, the thigh still in the first position. The plaster should be applied over woven woollen drawers, any parts of it that are not wanted being cut away afterwards. An anæsthetic is usually necessary. The plaster bandages, in the form of a spica, should surround the abdomen and the affected thigh as far as the fold of the bent knee. It must not interfere with the flexion of the unaffected thigh.

When the plaster is set, the child is encouraged to walk, which it can soon do remarkably well, apparently not minding the inconvenient attitude. The object of making the child walk is to make the hip-joint take on its function; the head of the femur and the cavity of the acetabulum react on each other, so that in course of time the former becomes more spherical and the latter deeper, and the chance of redislocation ever less and less likely.

After six months the plaster is removed, and a fresh radiogram taken: if this shows the bones in place the plaster is reapplied, this time with the thigh flexed and abducted

45 degrees ("second position")—*i.e.*, with the limb half brought down from the "first position." It will be found that the femoral head still remains in the acetabulum. This plaster is retained for another six months, the child walking daily; it is then removed, and if the radiogram be still favourable, reapplied with the thigh flexed and abducted still less—say, only 20 degrees from the straight ("third position"). This plaster is worn for a further six months, when it is left off altogether, and the child allowed to run about as it likes. Eighteen months will thus have been spent in plaster, during the whole of which the head of the femur has been forcibly kept in contact with the acetabulum. At the end of it, partly owing to the bone change resulting from the reaction of one bone on the other, and partly owing to contraction of the capsule, there is no longer any tendency for the dislocation to recur, even when the limb is brought down quite straight.

Remarks.—If you fail to reduce the dislocation at the first attempt, wait a week, and try again. If again unsuccessful, give it one more chance a week later still. If this time you fail, you had better desist from further efforts and regard the case as belonging to the irreducible ones. Attempts to replace the bone by open operation are not recommended.

If too much force is used, fracture of the neck of the femur or separation of its epiphysis may be caused, a most regrettable accident. A crack is heard, and the limb becomes more movable, not fixed or locked as in the case of reduction. There is nothing to be done except give up all thought of reduction and put the limb at rest in plaster in the "second position."

As to how perfect a result will be obtained in a given case it is impossible to say beforehand: probably the chief factor concerned is the amount of the anterior curvature of the neck of the femur. Sometimes it is impossible after a few years to tell which was the affected side; but in most cases a slight limp, immeasurably less, however, than the original waddle, will always remain. If left alone, the

waddling, rolling gait and unsightly lordosis will always be there, the patient remaining an obvious cripple to the end of his days.

3. Spastic Paralysis (Little's Disease).

In this condition there is a paralysis, with spasm of the extremities, dating from or shortly succeeding birth, more rarely following the fevers or an attack of convulsions. The legs are usually more involved than the arms; there is no wasting, no disturbance of sensation. The reflexes are increased. The mental condition is usually much disturbed. A large proportion of the cases result from injury at birth (Osler). Nothing may be noticed wrong with the child until it is time for it to walk, when a stiffness of the legs is discovered; when held up, it points its toes and crosses its feet or its legs, making no effort to stand. There is spasm of the muscles, chiefly noticed in those of the calf, in the quadriceps, and in the adductors of the thigh, producing contraction of the tendo Achillis, rigid extension of the knee, and adduction of the thigh, so that one thigh may cross the other. The arms may be affected equally with the legs. There is nearly always some mental defect, and the child may be an actual idiot. There may be frequent attacks of convulsions.

Treatment.—Only the slight cases seem to be worth treating, where the child's intelligence is normal or but slightly impaired. It has been suggested that by making the child stand and walk one can improve its intelligence and help it to get better; but in my experience this does not happen. The treatment consists in dividing any obviously contracted and shortened tendons, in preventing the contraction recurring, and in laborious and persistent education of the patient as to how to stand and walk.

In a typical slight case a general anæsthetic is given, and the tendo Achillis of each foot lengthened as already described, the feet being dorsiflexed and placed in right-

angled tin night-shoes. The child is then placed on his back, and all tight bands which stand out when the thigh is forcibly abducted are divided subcutaneously with a tenotome, as in the operation for reduction of congenital dislocation of the hip. These bands probably consist of the tendinous origins of the adductors longus and brevis, and gracilis muscles. The thigh will now lie in the "first position," and should be kept there on a straight splint for a week, or until all discoloration of the skin from extravasation of blood has disappeared. The night-shoes are taken off, and the child made to walk about holding on to the furniture of the room. Every night the feet are replaced in the night-shoes, and the thighs forcibly but gently abducted fully by the mother for a minute or so to make sure that the adductor contraction does not recur.

When the child is able to stand alone, it has to be taught to walk. The easiest way is for the surgeon to hold the child's hands in his own, and slowly walk backwards while the child advances. Only constant teaching will enable the child to walk steadily with its feet pointing straight forward and the proper distance apart. The mother must be shown what to do and how to do it, and she is to carry out this educational treatment daily; but as often as possible the surgeon himself must take the child in hand and train it to do what he wants.

Besides standing and walking forwards, the child must also be taught how to walk backwards and sideways.

Operative treatment on the upper limbs is not advisable. It should be noted that no brilliant results are obtained in the treatment of these cases, but only moderate effects, after prolonged and laborious efforts.

4. Deformities of the Fingers and Toes.

Contracted Digits.—Occasionally a child is born with a finger on each hand, usually the fifth, flexed up into the palm. Examination shows there is a shortened condition of the flexor tendons. Regular passive stretching of the

tight structures for ten minutes night and morning, with the wrist flexed, by the mother or nurse will often remedy this; but if after a few months this produces no improvement, the child must be anæsthetised and a fine tenotome introduced under the skin, and all tight structures divided until the fingers can be completely straightened. Thereafter daily stretchings for a few months are necessary to prevent relapse.

A similar condition is met with in the toes. They appear bent on themselves, so that, when the child stands, the nails, instead of lying horizontally, lie vertically, and are pressed into the ground. Corns soon develop on the tips of the toes if this is not attended to. The toes require to be stretched straight daily by the nurse, and in the intervals kept continually stretched out by being passed through elastic loops attached to a small metal sole-plate (Fig. 4), worn beneath the foot next the skin, inside the sock and shoe. In a severe case it may be first necessary to divide the contracted flexor tendon with a tenotome.

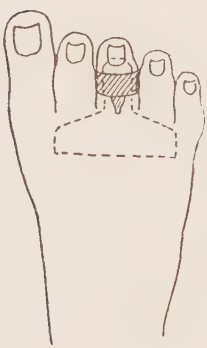


FIG. 4. — METAL SOLE-PLATE, WITH ELASTIC LOOP FOR TOE.

The little tongue holds the loop in position as the toe is passed into it. The plate lies under the foot, next the skin, kept in position by the loop.

Webbed Fingers and Toes (Syndactylism). —Two or more fingers may be joined together by a web consisting of two layers of skin and subcutaneous tissue; this may extend throughout their entire length or only involve the proximal portions. The only cure for this condition is operation, but it is not likely to be of much use unless there be a normally formed bony framework in the fingers it is intended to separate. If a radiogram show this to be present, a flap operation should be done, taking a palmar flap from one finger and a dorsal flap from the adjoining one, the flaps extending to the mid-line of the fingers (Fig. 5). The remaining web, consisting of subcutaneous tissue, is divided, and the dorsal flap of one

other, and vice versa. Separation of webbed toes is not usually required.

Supplementary Fingers and Toes (Polydactylism).—A child may be born with an extra finger or toe. This may occur in the same family generation after generation. The condition is usually bilateral, and occurs more frequently on the ulnar border of the hand and outer border of the foot than elsewhere. The extra finger or toe may be perfectly formed, or only partly present, or fused with the adjoining

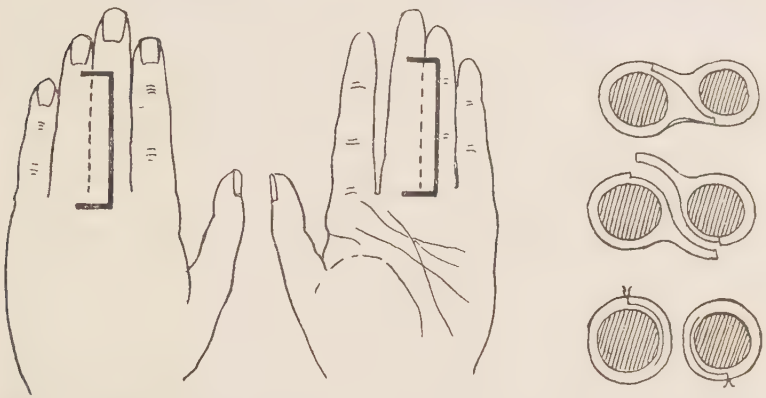


FIG. 5.—DIDOT'S OPERATION FOR SYNDACTYLY.
(From Bradford and Lovett.)

Didot's operation in cross-section.

one. Treatment consists in removal of the extra part a few months after birth. Before operating, a radiogram is advisable. In the foot, operation is indicated almost as often as in the hand, as the presence of an extra toe is likely to cause trouble in obtaining footwear. Moreover, a child is apt to be much teased by his school-fellows if he possesses an abnormality of this kind.

Various Congenital Defects.—Spina bifida, intra-uterine amputations, and absent bones or muscles are conditions too uncommon to be included in the present book.

CHAPTER II

DEFORMITIES ACQUIRED AT BIRTH

1. Torticollis (Congenital Non-Spasmodic Wry-Neck).

At birth one or other sternomastoid muscle may become partially ruptured, as shown by a hard swelling about its middle due to extravasated blood. If this be noticed early, say within the first month of birth, and certain exercises (see later) be passively carried out every day, no deformity will result, and the condition will be cured. But should it not be noticed or not treated for several months, by which time a definite contraction of the muscle has taken place, with consequent deformity, it will be found very difficult to stretch the muscle at all, however carefully the exercises are persisted in. I believe it to be a rule that you will be able to stretch the muscle if a lump is still present upon it; but that if the lump has disappeared, leaving only a fibrous scar, stretching will not be possible.

The deformity produced is always the same: the head is twisted away from the side of the affected muscle, the chin is raised, the ear on the affected side is lowered towards the shoulder. The head is, in fact, held in the position in which the patient would put it if he were listening intently with the ear of the affected side. Secondary effects of this position are (1) an inequality of the two sides of the face—the half on the affected side becomes smaller and flatter; and (2) lateral curvature of the spine.

The condition must be diagnosed from (1) spasmodic torticollis, due to a protective spasm of the sternomastoid to guard an inflamed cervical gland; (2) rheumatic torticollis, the ordinary "stiff neck"; (3) the rare condition of ocular torticollis, due to errors of refraction.

The length of history readily distinguishes it from the

first two, which are transitory affections: from the third it is diagnosed by laying the child supine, and seeing if it be possible to put the head straight; if it be possible, then there is no real shortening of the muscle. Moreover, on the prescription of suitable glasses the deformity vanishes.

To estimate the *severity* or *degree* of deformity the child is laid supine, with the head as straight as it will go, and the distance between the lobe of the ear and the suprasternal notch on the affected side compared with that on the other; a difference of as much as 3 inches will sometimes be noted. This measurement cannot be made when the child is standing, as the effect of gravity on the position of the head and on the secondary lateral curvature of the spine hopelessly confuse one; but lay the child down, and the effect of gravity is got rid of at once. Thus torticollis affords a good example of the rule that in acquired deformities the deformity is divisible into two portions, a "postural" and a "structural," and that in order to judge of the severity of a case, and obtain an accurate record, we must temporarily abolish the postural portion and measure only the structural; for the former may vary from hour to hour, while the latter remains constant or gradually increases.

Treatment.—Having come to a decision in a given case that stretching will not lengthen the muscle, it is necessary to divide it by operation. In nine cases out of ten all that is required is division of the sternal head of the muscle, followed immediately by stretching of the deep fascia. In the tenth case, when the sternal head is divided, the clavicular head springs up to take its place, and, lying prominently under the skin like a bowstring, can likewise be divided. The best way to divide the muscle is by subcutaneous tenotomy. I absolutely condemn the "open operation" so favoured in textbooks—it is entirely unnecessary; through the incision made the surgeon is tempted to divide various structures he had much better leave alone, and an unsightly scar frequently results.

Technique. — General anæsthetic: paint root of neck with iodine; while tendon is being made prominent by

gentle traction, introduce, with blade held vertically, a sharp-pointed, short-bladed tenotome immediately to inner side of sternal head, ½ inch above sternum: when way clear to tendon, withdraw, and insert blunt-pointed, long-bladed tenotome: insinuate it carefully behind tendon: turn blade at right-angles to tendon, and stroke the tendon with little short, firm strokes while the anæsthetist keeps the muscle on the stretch; the tendon gradually gives way as bundle after bundle of fibres are cut through: there is no hurry: half a minute may be taken to divide the whole tendon. When divided, withdraw tenotome, and at once seal opening with collodion and gauze. After division of the sternal tendon the clavicular tendon, if it require division, at once springs up into the area of operation, and appears as a tense band under the skin, just as the sternal tendon had previously done. The sharp tenotome is again taken, a vertical puncture made at the inner side of this tendon, and the operation completed exactly as before. No attempt must be made to divide bands of deep fascia with the tenotome. After the first puncture has been sealed, or, if both tendons have been divided, after the sealing of the second puncture, the surgeon takes the patient's head and firmly but gently twists it round till the chin is over the shoulder of the affected side; as he moves it round, any bands of fascia which perhaps still retain the head in a bad position give way. Turning the head straight again, he now bends it sideways until the ear on the unaffected side can be made to touch the shoulder on that side. The head is then laid straight, a pad of gauze fixed over the sealed puncture or punctures with strapping, and the patient left lying flat in bed, with head turned to the affected side, without a pillow, until next day, when the same two movements are performed once each. On the third day the patient is allowed up.

After-Treatment.—In order to hasten the assumption of a straight position and prevent relapse (though relapse is rare) two simple exercises should be carried out daily for three months—"head turning," and "head sideways bending."

(1) *Head Turning.*—The child lying supine on a table, the head is slowly rotated as far as it will go to the right, then slowly to the front, then slowly to the left, then slowly to the front again, the patient counting audibly, one, two, three, during each movement. This is repeated six times.

(2) *Head Sideways Bending.*—The child lying supine on a table, the head is laterally flexed slowly to the right, so as to bring the right ear close to the right shoulder, then brought slowly back to the mid-position, then laterally flexed slowly to the left, so as to bring the left ear close to the left shoulder, then slowly back to the mid-position again. During this exercise the child looks up at the ceiling, and the back of the head rests on the table, in contrast to exercise No. 1, when he looks alternately over one shoulder and then over the other. As in the former exercise, the patient counts aloud during each movement, which is repeated six times.

At first these movements are performed passively by the surgeon; but the child is encouraged to help actively, and by the fourth or fifth day he can do them perfectly well by himself. The mother is then shown what the exercises are, and is made to carry them out in the presence of the surgeon. It is explained to her why the exercises are ordered, and why she must continually correct the child if he at first holds his head crookedly.

The use of retentive apparatus after this operation, apart from its irksomeness, is entirely unnecessary. If the condition has been left untreated for years a secondary lateral curvature will have developed, and this will require appropriate treatment by posture and exercise (see p. 85).

2. Birth Palsy (Erb's Paralysis, Obstetric Paralysis).

This is caused at birth, usually as the result of prolonged labour or instrumental delivery. It may occur after normal labour. Traction upon the head in head presentations or upon the body in breech presentations is the exciting cause. The actual lesion is a rupture of the upper roots, fifth and

sixth cervical, of the brachial plexus. The muscles involved are the deltoid, biceps, spinati, supinators of the forearm, and extensor carpi radialis longior. If all these muscles be affected, as in a well-marked case, the child's limb hangs in a typical attitude, useless by its side, rotated in at the shoulder, pronated and flexed at the wrist. In a confirmed case, which has not recovered, the condition has been jokingly called "policeman's hand."

If taken in time, these cases usually recover largely,

FIG. 6.—FAIRBANK'S SPLINT.

The arm is held abducted to something approaching the right angle at the shoulder, the elbow is at a right angle, the forearm is supinated, and if desired, and the splint is made long enough, the hand and fingers can be fixed in extension. The splint (*a*) is made of tin, and consists of one long straight arm-piece riveted to an oblong, slightly thinner, body-piece, in the form of a letter T. It is padded and then bent so that the oblong piece lies around the chest on the affected side, and the arm-piece makes two abrupt curves at a right angle (*b*). Webbing straps and buckles are attached to keep the splint in place. One long strap passes from the upper posterior angle of the body-piece, across the back and round the front of the opposite shoulder, over a layer of cotton-wool, to return to the point on the splint from which it started. This prevents the whole splint from slipping round to the front and allowing the elbow to come forward. If posterior displacement of the head of the humerus is to be avoided, the elbow must be kept back in line with the shoulders. (The splint is supplied by Messrs. Sillis.)

being treated as for paralysis elsewhere. The affected muscles must be completely relaxed in suitable apparatus, notably Fairbank's splint[1] (Fig. 6), massaged daily, and the tendency to deformity counteracted by daily systematic passive counter-movements; thus the arm must be abducted and rotated out, the elbow flexed, the forearm supinated, and the wrist dorsiflexed. (Voluntary assistance on the part of the infant patient is, of course, not possible.)

If the muscular relaxation is persisted in, and these movements and massage carried out, recovery will soon begin to take place, to what extent in any case it is, however, impossible to say. In one there may be almost complete recovery, in another very little, the patient growing up with a limb shortened, withered, and much restricted in usefulness. Operative treatment on the nerves is not to be considered. Some improvement may be caused in a neglected case by division through open incision of the pronator radii teres, which has become permanently contracted.

3. Hemiplegia in Children.

According to Osler, in the great majority of cases the disease sets in during the first or second year. In some it is said to be present at birth. Injury during labour may be responsible for some of the cases, but a large proportion appear after one of the specific fevers. In some cases the paralysis gradually disappears, and leaves scarcely a trace as the child grows up.

In such a one all that is noticeable is a slight wasting of the muscles of one leg, without shortening of the limb and without vaso-motor disturbance, which distinguishes it clearly from infantile paralysis. I have never seen any shortening in a case of this sort. If the paralysis in the arm does not clear up, there may be some fixed flexion of the elbow, pronation and flexion of the wrist, and contraction of the fingers. Treatment is the same as for paralysis elsewhere—namely, relaxation of the paralysed muscles by suitable splints, and electrical and voluntary stimulation as soon as there is any sign of return of power.

[1] *Lancet*, May, 3, 1913. Lecture on Birth Palsy.

CHAPTER III

DEFORMITIES ACQUIRED AFTER BIRTH

A. Due to Rickets.

Rickets, which is responsible for an enormous amount of deformity among the poor, is generally held to be due to unsuitable feeding. According, however, to a theory put forward by Dr. Eric Pritchard, it is due to relative *overfeeding*; the blood, being unable to deal with the excess of food, becomes loaded with semi-oxidised products, with, among other results, the destruction of red corpuscles; the red corpuscular-forming areas in the bones, which in children are situated principally about the epiphyses, become stimulated to make up the loss, hypertrophy, and so produce the enlarged epiphyses which are such a common feature of the disease. The treatment he advises is less food, active exercise, and fresh air. Others attribute its presence to the *absence* of *sunlight.*

The general treatment which I prescribe in hospital is (1) a diet from which potatoes, biscuits, and jam are absent, and which consists at regular times of plenty of milk, fat, dripping, meat, eggs, oranges, apples and bananas, green vegetables, and a little bread (the net result of this diet is certainly to reduce the actual bulk of food taken); (2) cod-liver oil and malt, or extract of malt alone, three times a day; (3) exposure to fresh air and sunlight as much as possible; (4) the child to be encouraged to kick its legs and wave its arms, and, later, to crawl about the floor. The reverse of this treatment is to stuff the child with potatoes and biscuits, wrap it up in eight or ten layers of clothing and blankets, and hide it all day in a pram with the hood up.

The disease usually comes on some time after the eighth month, and may persist acutely for a couple of years; so

treatment must be kept up for a considerable time. Relapses may occur.

The deformities which most frequently have to be corrected, and which are all due to softening of the bones, are bow-legs (curved tibiæ and fibulæ), knock-knee (genu valgum), and pigeon-breast.

1. Bow-Legs.

Though this may be occasionally due to changes in the shape of the femora, it is caused much more commonly by curvature of the tibia and fibula. It is customary to speak of "curved tibia" as if the fibula were not equally curved, but one bone cannot become bent without some curve in the other, and in the treatment both bones have to be corrected.

Clinically, cases of bow-legs can be divided at sight into the *mild*, which are curable by splints, and the *severe*, which require a division of the bones. Now and then a doubtful case presents itself which has to be treated experimentally as a mild case on the chance that it will get better; but with experience the number of doubtful cases becomes small. Even if a case be treated by splints for many months without improvement no harm is done, and the subsequent division of the bones will be just as effective as if done at first; time only is lost.

Considering first the *mild* cases, all that is required is the application of suitable splints, which must be worn during the day while the child is walking about. The ordinary padded wooden hospital splint, 2 inches broad, and 6, 8, or 10 inches long, is admirable. It should extend from the bottom of the shoe-heel to the line of the knee-joint, and be applied to the inner side of the leg and ankle over the sock and shoe, and bandaged on firmly. The bandage should come well down on the outside, and obtain a purchase from below the external malleolus. The splint is applied in the morning by the mother, and removed at night. The padding at the lower end of the splint will

soon wear out; when it does, the mother must re-cover it. The patient is seen every fortnight at first, and later every month. The splints are worn for from three to twelve months, being discarded as soon as the legs are quite straight.

The *severe* cases are treated by "manual osteoclasis" of both bones. The affected limb is grasped in both hands, and broken by leverage over a suitable fulcrum.

Technique—1. *Apparatus.*—The table must be a low one, with the top opposite the lower third of the operator's thighs, for he has to apply force vertically downwards, with

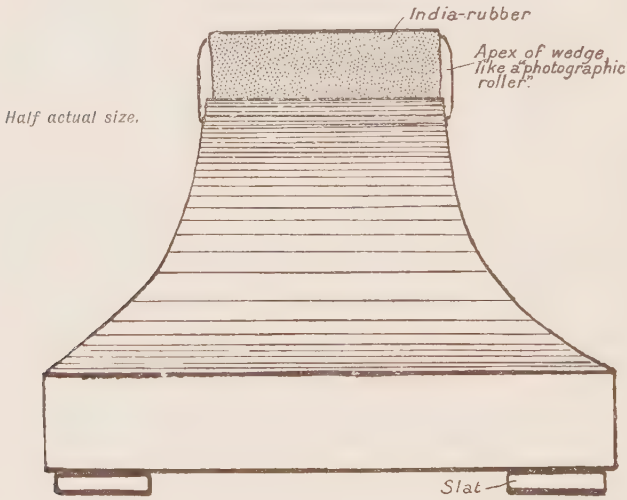


FIG. 7A.

his arms held straight and stiff. On the table are a firm pillow, on which the child's trunk rests, and the "orthopædic wedge" (Fig. 7A) over which the leg is to be broken. The trunk is raised on the pillow, so that the whole of the limb to be operated on is level with the top of the "wedge." The construction of the "wedge" is most important, as the operation over any but the proper instrument is very difficult and most unsatisfactory. This is made of polished wood, has a broad base with slats to make it stable, and narrows up to a rounded indiarubber-covered apex, looking like a photographic print roller.

2. *Preparation and Position of the Patient.*—Let us suppose that the right leg is to be dealt with. When the child is fully anæsthetised, he is placed on his right side, close to the edge of the table, with his back to the operator, and his trunk on the pillow (Fig. 7B). His right leg is extended, with the convexity of the curvature lying on the wedge, and the left leg is flexed up out of the way. The skin is now ringed round with a blue pencil mark exactly opposite

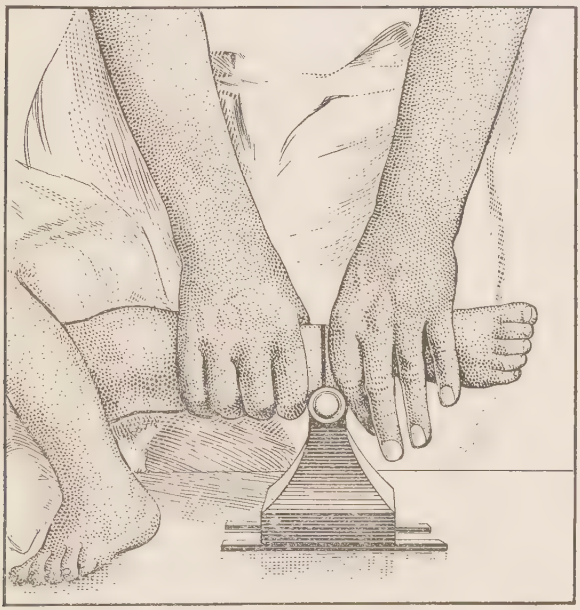


FIG. 7B.

the centre of the curve, and the wedge is carefully adjusted under the leg, so that the indiarubber apex coincides with the mark.

3. *The Operation.*—The operator grasps the limb with one hand above and one below the mark, but only separated sufficiently to see the mark, and leaning forward slightly, in order to get his own body immediately above the leg, proceeds gradually to let his weight act through his straight arms upon the limb. The break will not take place all at once; at first, the leg bends a bit; then, as more and more

downward crushing force is applied, a snap is felt and heard. This is usually the fibula. The operator continues as before until another snap is felt, when the sudden momentary overcorrection of the deformity proves that the tibia has divided. As a rule, the bones snap suddenly and audibly, but sometimes they bend slowly like soft iron, and with a crunching sound.

4. *After-Treatment.*—The limb is wrapped round, from the toes to the knee, with a few layers of thin cotton-wool, and is then bandaged in a slightly overcorrected position to the straight internal splint already described, the foot being included by a couple of figure-of-eight turns, so as to keep it at right angles to the leg. As soon as he recovers from the anæsthetic, half a drachm of syrup of chloral, or $\frac{1}{16}$ grain of morphia, is given to deaden the pain, which may be considerable. After two days the child is sent home. He is seen once a week, the splints being adjusted on each occasion, and at the end of a month he is allowed to walk, still wearing the splints for another fortnight, after which he may be considered cured. It will be some months before he walks and runs like other children.

5. *Remarks.*—When the operation is done in this way, the bones break opposite the centre of the curve. Displacement of the leg during the operation is at once noticed by the mark on the leg not coinciding with the apex of the "wedge," and the operator desists for a moment while he replaces the leg in exact position. When the leg bends before breaking, one feels tempted to leave it at that; but if one does, disappointment will result, for the deformity in a few days will be just as noticeable. To obtain the overcorrection necessary, fracture of the bones is essential.

2. Knock-Knee ("In" Knee, or Genu Valgum).

This condition starts as a purely postural deformity; when the child stands, the lower limbs sag in at the knees, owing to a relaxation of the ligaments around the knee-joints. After a time, the internal lateral ligament becomes permanently lengthened and the external shortened, while the pull of the former causes a lengthening downwards of the internal condyle of the femur, thus producing actual deformity of the bone. In no condition is the rule—that in acquired deformity part of the deformity is postural and part structural—better exemplified. When the child stands, the deformity may appear very marked, the feet being widely separated; but on laying the child down to get rid of the effect of gravity and to eliminate the postural element, the actual amount of structural deformity may prove very slight. To *measure* the amount of knock-knee, the child must be laid supine, with knees extended, the two adductor tubercles touching, the patellæ facing vertically upwards, and the feet dorsiflexed. The distance separating the two internal malleoli is the amount of knock-knee in that case. (If there be no knock-knee, the internal malleoli touch.) In measuring such a case, it is not enough to know the actual distance between the malleoli; we also want to know whether the malleoli can be brought together by using reasonable force. If they can, then the prognosis is very much better than if they cannot. This leads to a consideration of the *treatment*.

The legs have got to be straightened by some means. If this can be done at the first examination by using reasonable force, which implies that the bones have not yet become deformed, a cure can be brought about by means of splints; but if they cannot be so straightened, in all probability an operation will be necessary. Just as in the case of bow-legs, a few intermediate cases occur in which it is difficult to decide at once whether splints alone will bring about a cure or not; in these, splints must be given a good trial before resorting to operation. The best splint

for correcting knock-knee is a Thomas's calliper knee walking-splint with lateral knee-cap (Fig. 8). The latter draws the knee to the outer iron day and night: after two months the outer iron requires to be bent out an inch (see Appendix), and the lateral knee-cap draws the knee after it, thus producing overcorrection. This is maintained for two to four months, when the splint may be left off at night; after a further two months it may be left off altogether, a cure having resulted.—In very slight cases, where there is barely half an inch between the malleoli, even splints are not required; wedging of the inner side of the soles and heels of the shoes, as in the treatment of flat-foot, and attention to diet and feeding, bring about a cure. If a pony can be provided for the child to ride and curl his legs round, so much the better.

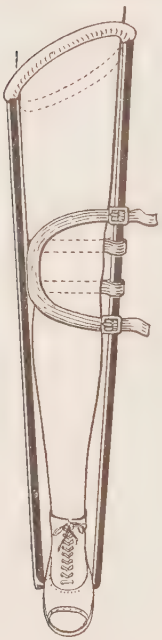


FIG. 8. — THOMAS'S CALLIPER KNEE-SPLINT, ARRANGED FOR THE CORRECTION OF A LEFT KNOCK-KNEE.

Measurements. — State left or right; horizontal circumference of thigh at perineum; length from perineum to centre of boot-heel. Tracing of leg. *Send boot* with order to have heel tube fitted. Mention *lateral* knee-cap.

If the legs cannot be got straight with reasonable force, as where there are several inches of separation, or if treatment by Thomas's splint has failed, there only remains operation. This consists in an osteotomy of the femur immediately above the condyles.

Technique of Supra-Condylar Osteotomy of Femur.—If the left femur is to be operated on, the child is turned over on to its right side, with the right thigh and knee flexed up out of the way. A large firm sandbag is placed beneath the lower end of the left thigh, the limb lying with the knee fully extended. The adductor tubercle is then felt for on the *inner* side, and at a spot on the outer side opposite this, but 1 inch higher up

towards the hip, a small incision is made with a scalpel through the skin and muscle down to the bone. The incision should be parallel with the line of the limb, and only long enough to admit the blade of the osteotome, which is inserted as the scalpel is withdrawn. When the osteotome is felt to be against the bone, it is rotated through 90 degrees, so as to lie with its blade at right angles to the shaft of the femur. With a sufficient number of blows from a wooden mallet the osteotome is driven through the femur so as to divide it. This is not altogether an easy matter or one devoid of danger. To control the osteotome and prevent it being driven too far or too quickly it must be wrapped round with a piece of gauze, and firmly grasped low down by the hand which holds it, so that the ulnar border of the hand is against the

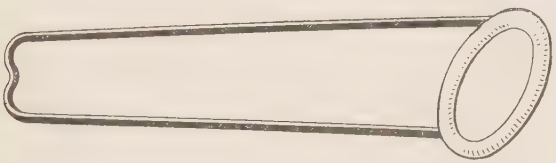


Fig. 9.—Thomas's Knee Bed-Splint (Right).

skin of the patient, only the gauze intervening. The instrument is not to be driven right through one part of the bone all at once; directly one feels it tightly wedged in the bone, one frees it by levering it from side to side, and moves it a little to one or other side before again using the mallet, thus extending the cut evenly across the whole width of the shaft. This process is repeated if need be several times until one judges the bone has been sufficiently cut through to allow of the remaining portion being fractured by the hands. This is then done, the osteotome is withdrawn, and the skin incision closed with one catgut stitch and covered with a gauze dressing. If the other leg is also to be done, the child is rolled over on to the opposite side, and the same procedure followed. The limbs must now be fixed in the corrected position; this may be done in a Thomas's knee bed-splint (Fig. 9, and see Appendix), one

for each leg, or in a box-splint (Fig. 10), or in plaster. I prefer the first mentioned, except in the case of small children, when the box-splint is best. If plaster be used, it must include the pelvis and foot. The corrected position must be one of slightly bowed legs. The splints will require to be kept applied for from four to eight weeks, depending upon the age of the patient. After they are removed the child should be allowed to kick its legs about in bed for another two weeks before attempting to stand.

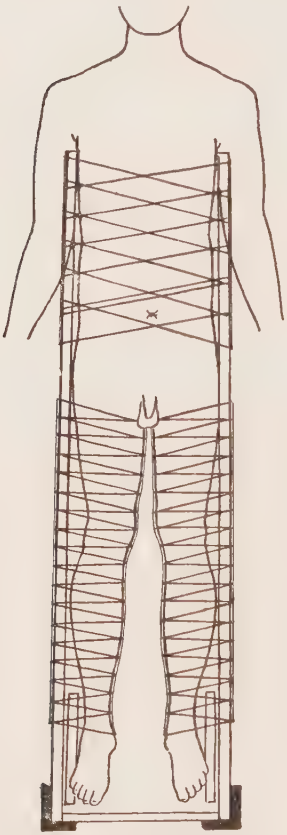


FIG. 10.—WOODEN BOX-SPLINT.

This consists of two long padded Liston splints joined together below by a short splint the length of the transverse diameter of the chest. The joints are strengthened with iron clamps. The child is bandaged into this, and laid on a flat mattress.

Remarks.—In some cases only one knee will require the osteotomy, the other can be corrected sufficiently with splint alone. Where a calliper-splint has been used to reduce the deformity without success, it can be converted into a bed-splint for use after osteotomy by fixing the two ends into a piece of metal tubing; and, conversely, in larger children, where it may be advisable to give some support during convalescence, the bed-splint can be converted into a walking-splint by cutting off the end and bending in the side irons.

By approaching the bone on the outer side, certain structures which lie on the inner side are avoided—viz., the internal saphenous vein, internal saphenous nerve, and anastomotica magna artery. The osteotome is entered

1 inch higher up than the level of the adductor tubercle, in order to avoid the epiphyseal line.

The operation done in this manner is practically bloodless, any oozing of blood during division of the bone being absorbed by the piece of gauze wrapped round the osteotome. There are two accidents to avoid, both caused by undue violence: one is injuring the popliteal artery, and the other is driving the instrument right through the skin of the opposite side of the thigh.

3. Pigeon-Breast.

A deformed chest is a common result of rickets. In a typical case the lower end of the sternum projects unduly, and the sides of the chest are flattened and run forwards to meet the sternum at an angle. The lower part of the chest is constricted as if by a ring; this constriction occurs opposite the attachment of the diaphragm, and is known as "Harrison's sulcus." At every breath the diaphragm pulls on the ribs and cartilages, and as they are weak they give way and bend inwards, producing this deformity. Sometimes only one side will give way, producing in later life asymmetry of the chest; but more often the ribs give way all round. As this bending in reduces the capacity of the chest, the lungs find room for themselves by pushing out the sternum, which may in turn become deformed. Treatment of a case, if started early, is extraordinarily successful. Apart from an antirachitic diet, it consists of breathing exercises, exercises of the legs, and arms, and neck, and spine, and of strict attention to posture and clothing, the whole forming the method known as treatment by "posture and exercise" (see Treatment of Scoliosis). As a result of this treatment, provided the child has not been left alone for too many years, all the deformity can be made to disappear.

CHAPTER IV

DEFORMITIES ACQUIRED AFTER BIRTH

B. Due to Infantile Paralysis (Acute Anterior Poliomyelitis).

This is an acute infectious disease, due to a specific organism, causing inflammatory destruction of the motor cells of the anterior horns of the spinal cord, occurring usually in the second and third years of life, characterised by fever, sudden loss of power of certain muscles, and subsequent atrophy.

The infectious nature of this disease has now been established beyond a doubt, and all cases should be isolated while the acute symptoms last. The infective virus is present in the nasal and buccal secretions. Flexner and Noguchi (1913) claim to have actually isolated the organism. The disease can be transmitted to monkeys.

The incubation period lasts from one to four days, and the disease commences, as a rule, with high temperature, convulsions, and much pain in the limbs and spine (the acute stage). After two or three days these symptoms abate, and the child is found to be suffering from paralysis of certain muscles (subacute stage).

In the course of the next few months there may be considerable recovery from this paralysis, and in some cases hardly any trace of the disease remains; in the majority, however, more or less wasting of muscles takes place, with permanent paresis and shortening of the affected limb. As years go on (chronic stage) this wasting and shortening become more marked, unless appropriate treatment is carried out. As regards the part affected, the lower limbs suffer in 70 per cent. of all cases, the upper limbs much less frequently, and isolated muscles, such as those of the

trunk or neck or eyeball, only rarely. When the lower limbs are affected, the anterior tibial group of muscles are paralysed more often than any other; but in the upper limb, the affected muscles are usually the deltoid and biceps, the forearm and hand escaping.

Treatment of Infantile Paralysis.—In the acute stage, and for a month afterwards, absolute rest is indicated, not only to the affected limbs, but also to the spinal cord. The child should be kept warm in bed, on a flat mattress, isolated from other children, with the affected muscles relaxed and their opponents prevented from overacting by the use of suitable splints (see later). The affected limbs should be wrapped in cotton-wool, the child should be fed and washed while lying supine, and every care taken to prevent the child making a single voluntary effort with limbs or spine or head. There is inflammation of a part of the spinal cord, and we want it to subside; therefore the less work we give it to do the more chance it has to recover. On no account should massage or electricity be applied at this stage: they will only do harm. Rest is everything. When the acute stage has passed, and a month has been spent as above described, the treatment to be followed depends on four broad principles.

1. The maintenance at all times of the natural temperature of the affected part.

2. The relaxation of the affected muscles so as to prevent them from becoming stretched and their opponents contracted.

3. The exercising of the muscles so soon as they show any return of voluntary power.

4. The prevention of deformity by suitable apparatus.

Let us discuss these four principles in detail.

1. *The Maintenance at All Times of the Natural Temperature of the Affected Part.*—It is still an everyday occurrence to meet cases of infantile paralysis which have been treated for years by instruments, massage, and electricity, without any attempt having been made to keep the limb warm. When the instrument and stocking are removed, we find

a bluish wasted limb, disfigured with the scars of broken chilblains, and inches shorter than the other one. Yet if the limb be kept warm, there will be little wasting, no discoloration or chilblains, and no further shortening. The way to keep it warm is by putting on sufficient clothing. The best plan is to get the limb warm in bed, or in a hot bath, and then to add layer after layer of stocking until the limb will remain as warm as the other one all day. When the child is fitted for a boot, the measurement must be made over this extra clothing. If this is not done, efforts to keep the limb warm by the application of extra stockings only result, when the boot is put on, in cramping of the toes, pressure sores, and callosities, and a worse state of circulatory stagnation than before. In addition to the stockings, for outdoor use after the boot is put on, a gaiter lined with cat or rabbit skin should be worn with the fur turned towards the limb. Girls wear these gaiters till they grow up; as soon as boys are old enough they can be put into trousers, and the trouser leg of the affected side lined with the fur. At night in bed it may be necessary to wear a stocking, but not nearly so much extra clothing is required as in the daytime, for in bed it is usual for the paralysed limb to keep warm without extra clothing of any kind. This is due to the warmth afforded it by the healthy limb, to the little loss of heat undergone when cosily tucked up in bed, and also to the horizontal position of the limb. This leads to an important point in treatment, *never to let the affected limb hang down*. When it is not being used, the arm should be supported in a sling; the leg, when the child is sitting, upon another chair. Be the vasomotor system of the limb ever so seriously affected, it can still carry on its work if sufficient help is given it by minimising the heat loss and reducing the peripheral pressure. And if it carry on its work every one of the tissues will receive its normal amount of blood, and thus many of the classical signs of infantile paralysis will never even make their appearance. To what extent the sequelæ of an attack of poliomyelitis are due to the vasomotor disturbance I am

not prepared to say, but that they are largely due to it there can be no question. Even the muscular paresis is largely influenced by it, for one has frequently noted good movement in a limb, when made warm before the fire, in which, when cold, there appeared to be no voluntary movement at all. Every morning and evening the circulation may be still further assisted by ten minutes in a hot bath (105° F.). It is customary in these cases to order massage, because it is able to restore the circulation in the part for the time being; but if, as in the simple manner described, the part be kept warm and the circulation good always, the need for massage vanishes, and it can then only be considered a luxury, not a necessity. I only recommend massage in those rare cases when the limb cannot be kept warm, which are, fortunately, few and far between.

2. *The Relaxation of the Affected Muscles so as to Prevent them from becoming Stretched and their Opponents Contracted.*—Nothing is more disheartening to the orthopædist than the examination of case after case of poliomyelitis in which the foot has been allowed to drop, though under medical treatment all the time. With the dropping of the foot the tendo Achillis becomes contracted, and often secondarily to this the hamstrings follow suit. A cutting operation is now usually necessary to repair the negligence of the medical attendant. If a case be treated efficiently from the start, a tenotomy will never be required. The harm caused by allowing the foot to drop is only in part the obvious disability of a shortened tendo Achillis, which can be remedied by operation; much more to be deplored is the stretching and elongation of the paralysed extensor muscles. For when recovery begins in the nerve, and impulses are sent along it to dorsiflex the foot, though the impulses would cause healthy muscles to do so, they are quite unable to produce a sufficient contraction in the stretched muscles. If the muscles are already relaxed, they are in the best condition for contraction, but if stretched they are in the most unfavourable state for it. The treatment to adopt, therefore, is in some manner to relax

the affected muscles—that is, in this particular case, to prevent foot-drop. This is done by applying to the foot and leg a right-angled tin night-shoe, and making the child wear it day and night until recovery in the muscles is well advanced. The ideal treatment is never to let the foot drop down once. In all probability it will need to be worn at night for years. It is not sufficient to tell a parent or even a masseur to move the foot every day to prevent it from becoming dropped; slowly but surely the foot will become fixed in a dropped position if it be not kept in a right-angled splint.

And so with the various other groups of muscles affected. If it be the posterior tibial group, an obtuse-angled tin night-shoe is indicated; if the quadriceps, a Thomas's knee bed-splint. In the arm, where the muscles usually paralysed are the deltoid and biceps, Fairbank's splint should be used, which keeps the arm abducted and the elbow flexed. If the erector spinæ are weak, the child should be kept as much as possible in the position of opisthotonos, using a convex padded "back board" of iron, with pillows placed transversely beneath it; later on, the child is made to lie most of the day in the prone position, with the upper part of the trunk supported on the elbows. If the neck muscles are affected, Thomas's collar (Fig. 11) is the best arrangement to use. In each case the muscle is relaxed into what is called its "zero" position. It is to be hoped that this principle, the relaxation of paralysed muscles during the period of repair in the nerve supplying them, will soon be recognised generally and employed in all nerve lesions where recovery is hoped for. The period of repair in poliomyelitis usually extends over two or three years; you are not doing all you can for the case if you do not keep the muscles relaxed for practically the whole of the time.

3. *Exercising the Muscles as soon as they show any Return of Voluntary Power.*—Voluntary power may return to the muscles quite soon after the acute attack, or may be delayed for many months, or may never return at all. To discover

its presence, once a month the part should be carefully removed from its splint and tested for it. The method to be used in testing has been clearly described by Dr. Abercrombie in a paper, "The Treatment of Muscular Paresis by Means of Eccentric Movements," in which he emphasises the importance of eccentric as opposed to concentric movements. "By a concentric movement is meant the ordinary movement of a muscle which does work while becoming shorter; on the other hand, a muscle is said to perform an eccentric movement when it does work while becoming longer." Thus, if a patient be asked to dorsiflex his foot

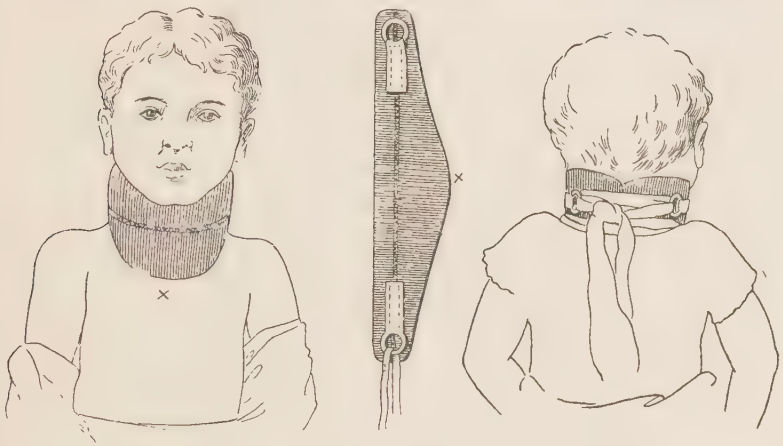


FIG. 11.—THE "CERVICAL COLLAR."

(From Thomas's "Contributions to Surgery and Medicine.")

while you hold his toes and resist the movement, you are making him perform a concentric exercise with his anterior tibial group of muscles; whereas, if you passively dorsiflex his foot and then try to plantar-flex it while he resists, you are making him perform an eccentric exercise with the same muscles. The importance of the distinction lies in the fact that when function is returning to a paralysed muscle, power to act eccentrically can be elicited long before there is any power to act concentrically. Thus, in a case of recovering wrist-drop, power to prevent the

wrist dropping returns before power to raise it; and quite often this eccentric power can be demonstrated in an apparently hopelessly paralysed limb, especially if means be taken to cut out the effect of gravity by laying the limb on its side or placing it in a bath of water. When once we find any return of eccentric power, the limb must be exercised in this manner repeatedly for twenty minutes daily with a view to still further increasing it. As days pass, the patient is able to put out a greater and greater effort to prevent his wrist being passively palmar-flexed, until the day comes when he can very slightly dorsiflex the wrist voluntarily—that is, can perform a concentric movement. From this point recovery may be rapid.

This brings me to another important point in treatment, *the use of the patient's own will.* The importance of the stimulus of the patient's will was recognised many years ago by my grandfather[1]—"as soon as possible rouse the action of the paralysed muscles by the most important functional stimulus of the will, which cannot be replaced by any other." In carrying out eccentric exercises the patient's will is brought specially into play, and it is partly owing to this that they prove so successful.

When recovery has become stationary, and no further improvement appears to be taking place, every effort is made to get the patient to move and use the affected limb, so that, when possible, the unaffected or partially affected muscle fibres may take on compensatory functions. If the leg is paralysed, he is encouraged to walk and run; if the arm, the good arm is bound to the side for a fixed time every day, and the affected one only allowed to be used. If these voluntary but unrestrained efforts be allowed earlier in the treatment, they will result in stretching of the weak muscles, and so retard recovery.

4. *The Prevention of Deformity by Suitable Apparatus.*—This may be necessary in the lower extremity, in the spine, and in the neck.

Lower Extremity.—If the condition be so severe that the child cannot walk, or that he can only walk with great

difficulty, or with obvious tendency to the production of deformity, a walking instrument must be provided, but not otherwise. For when an instrument is worn, although it favours muscular recovery to a certain extent—*e.g.*, in a very bad case which could not walk at all without it—yet, after a certain point has been reached, it hinders further recovery by doing the work of the muscle for it. Therefore it should be applied sparingly, and not retained too long. Not nearly every case of poliomyelitis requires a walking instrument. Where there is a simple varus or simple valgus condition of the foot, a $\frac{1}{4}$-inch wedge of leather applied to the outer or inner side respectively of the sole and heel of the boot is usually quite sufficient to tilt the foot into the reverse position. Where the valgus is marked, the outer side of the upper of the boot may be stiffened with a thin vertical plate of metal, a so-called "concealed spring," $1\frac{1}{2}$ inches wide (Fig. 36), which turns in at right angles to lie beneath the heel. This plate has an outward bulge opposite the external malleolus, so as not to rub it. When the boot is laced up, the inner side of the foot is pulled over towards the metal plate on the outside. Where there is foot-drop, some method must be adopted to keep the foot raised. In infants this can be done by introducing beneath the tongue of the boot, between it and the stocking, a strip of thin white metal, curved on the flat to such a degree that it just corresponds with the natural curve of the dorsum of the foot and ankle when the foot is at right angles to the leg. To make this strip lie comfortably, in addition to it being curved on the flat—that is, longitudinally, with concavity forwards—it requires also to be curved transversely, with concavity backwards. In older children, where the weight of the foot prevents the use of this method, a single walking instrument to the knee, with uplifting toe-spring, is the best apparatus to use. The lower end of the spring terminates in a strap which splits to be attached to either side of the boot opposite the balls of the toes. If the foot is varus or valgus as well as equinus, the spring can be arranged to pull only on the outer or inner side of the boot

respectively (Fig. 12A), so as to overcome those deformities, which it does most efficiently. Sometimes, when the valgus deformity is very marked, a valgus T-strap must be added to get the foot straight (Fig. 12B). This is sewn to the inner side of the heel, passes vertically up to cover the internal malleolus, and then divides to encircle the ankle and

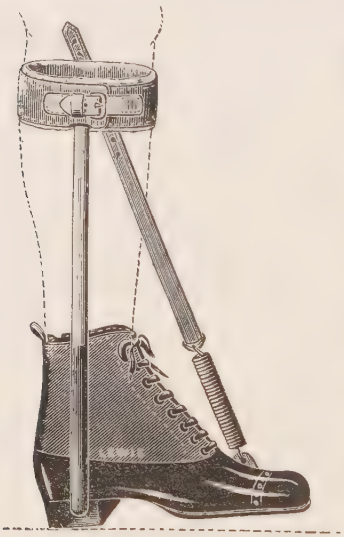


Fig. 12A.

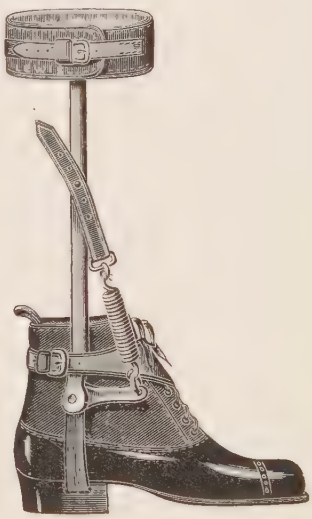


Fig. 12B.

Fig. 12A.—Walking Instrument, Single to the Knee, for Right Boot, with uplifting Toe-Spring arranged to counteract the Tendency to Valgus Deformity.

Fig. 12B.—Walking Instrument, Single to the Knee, with Valgus T-Strap and uplifting Toe-Spring for Right Boot.

Note (1) that the lower end of the steel fits into a socket in the heel of the patient's ordinary boot; (2) that the strength of the spring can be adjusted. When a T-strap is used, it is convenient to have the uplifting toe-spring arranged as shown.

be buckled round the single iron of the instrument, which is placed on the outer side of the leg. When the strap is tightened, the ankle is pulled over to the iron. When the knee tends to flex, the quadriceps being weak, a Thomas's calliper knee walking-splint should be used

(see Appendix), with a knee-cap in front of the patella; if an uplifting toe-spring is required, its upper end will be fixed to the knee-cap (Fig. 13), or to one of the side irons. Bands behind the leg and thigh prevent retroflexion. If there be knock-knee, a lateral knee-cap draws the knee outwards to the outer iron. If there be rotation out of the limb at the hip, it can be counteracted by altering the obliquity of the tube in the boot-heel which receives the ends of the calliper. (This rotation out, however, is to be overcome when possible by educating the child to walk with the toes pointing straight forward.)

In children it is an advantage to have the knee kept extended if the quadriceps is weak; as they grow up it may become convenient to have the calliper splint jointed at the knee and controlled by a sliding-ring catch.

The calliper splint has numerous advantages over all other splints, the chief being its lightness, durability, simplicity, cheapness, and absence of sole-plate, enabling it to be fitted to the child's ordinary boot; moreover, two or more pairs of boots can be fitted with the heel-tubes, so that the same pair need not be worn every day, and the repairing of the boots does not necessitate the lying up of the child.

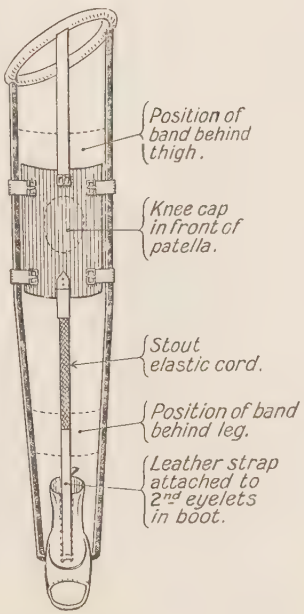

Position of band behind thigh.
Knee cap in front of patella.
Stout elastic cord.
Position of band behind leg.
Leather strap attached to 2nd eyelets in boot.

FIG. 13.—THOMAS'S CALLIPER KNEE WALKING-SPLINT, ARRANGED FOR THE TREATMENT OF INFANTILE PARALYSIS INVOLVING QUADRICEPS AND ANTERIOR TIBIAL GROUP OF MUSCLES.

Spine.—When a section of the erector spinæ on one side remains paralysed, a lateral curve is produced, with convexity to the paralysed side. At first this curve is only postural, and the case is treated as for ordinary lateral

curvature. If slight structural deformity develop, it can usually be prevented from becoming serious by a continuance of the exercises and positions; if, however, it rapidly increases, a support (Thomas's posterior spinal; see Appendix and Fig. 14) may be applied: but it is doubtful whether it will do much good. Only in those cases where the spine flops right over can one really feel that the support is the correct treatment. It will not, however, prevent a structural scoliosis from developing.

Fig. 14.—Thomas's Leather Posterior Spinal Splint.

Measurement. — Exact tracing of spine; length from top of shoulder to seat when sitting; circumference thorax, waist, and pelvis.

Neck. — When the neck muscles—*e.g.*, sternomastoids—are affected, and the head cannot be held up, Thomas's collar must be worn continuously. It is much more comfortable than plaster of Paris or poroplastic material.

Remarks on Poliomyelitis. —The stock treatment for this condition is "massage and electricity." Belief in this method has got implanted firmly in the mind of the public; it should be our endeavour to uproot it. As regards massage in these cases, it is difficult to see that it does anything more than improve the circulation of the part for the time being, and for just so long as the massage lasts, for half an hour perhaps out of the twenty-four; whereas sufficiently warm clothing will keep the circulation at its best for the whole of the twenty-four. As regards electricity, has anyone ever shown that it is really of value? It was introduced by Duchenne[2] in 1855, who firmly believed

it would cure infantile paralysis; he even thought it could produce a new muscle. Since then it has become immensely popular, and in countless electrical departments twice a week we find the paralysed limbs of little children put into baths along with a couple of electrodes. The apparent good produced by this treatment is due to the hot water, as can be proved by using the hot water alone. Even when the case has been treated with care, and each paralysed muscle stimulated separately with a button electrode, I have never seen any improvement result that I could not attribute to other causes.

These cases require constant supervision; they must be seen by the surgeon every three months for several years, and frequent alterations made in the boot-wedges and in the instruments to counteract the tendency to deformity in each one. If not carefully looked after deformities will develop, and the cases will become what are known as "neglected" ones, with malshaped bones, contractures, callosities, and ulcerating chilblains.

In very severe cases, where there are no muscles functioning at all—*e.g.*, flail knee and foot, or flail shoulder—it may be an advantage to ankylose artificially the joint concerned by the operation known as "arthrodesis." Occasionally a good result can be obtained by tendon transplantation, making a healthy muscle take the place and perform the work of an adjacent paralysed one. But for a description of the treatment of neglected cases, and of the operations of arthrodesis and tendon transplantation, the reader must consult more exhaustive works.

[1] Dr. M. Roth, "Paralysis in Infancy, etc.," 1869, p. 61.

[2] "D'Electrisation Localisée et de son Application à la Thérapeutique." Paris.

CHAPTER V

DEFORMITIES ACQUIRED AFTER BIRTH

C. Due to Tuberculosis of Bones and Joints.

General Remarks.—Tubercular disease of the bones and joints, together with tuberculosis of lymphatic glands, chiefly comprise that condition known as "surgical tuberculosis." At one time it was held that the bacillus responsible for this condition was altogether different from the bacillus causing tuberculosis of the lungs, the former being considered as due to bovine infection through impure milk, the latter the result of direct infection from some human being. This distinction has now been given up, and it is better to regard all manifestations of the disease, in whatever part of the body, as due to the same tubercle bacillus of however varying strain. When the disease does appear in any part, it is important to remember that this is merely a localised breaking out due to a general infection of the body, and that in dealing with it one must treat not only the former, but also the latter. The way to treat the *general infection* is to place the patient in ideal hygienic surroundings, where he will receive nourishing food of the best quality, bracing fresh air free from microbes and constantly changed, and direct sunlight for many hours daily. Given these conditions, the powers of resistance of the body against the invading bacillus become so intensified that they destroy it. These ideal conditions are obtainable in certain mountainous regions, as, for example, at Leysin in Switzerland, where the treatment has been elaborated with marvellous results by Dr. Rollier under the name of Heliotherapy. In his numerous cliniques

the patients are exposed naked to the direct action of the sun's rays (Fig. 15), and as they rapidly gain in health and strength the local manifestation of disease heals up. Under the combined effect of sunlight, air, and food administered under ideal conditions, swellings subside, sequestra are extruded, and sinuses close up (Fig. 16). Only very rarely is a surgical operation ever required. Combined simultaneously with

FIG. 15.—TREATMENT OF SURGICAL TUBERCULOSIS BY THE SUN.
(From a photograph by Dr. Rollier.)

this general treatment is fixation by suitable apparatus of the affected part. Now, although these conditions cannot be obtained in every country, a great deal can be achieved by approaching to them as nearly as possible. Thus, we can give the nourishing food, we can open the windows, and we can expose to the sun for at least a portion of the year.

In exposing a patient to the sun's rays, certain precautions must be observed, otherwise blistering of the skin or sunstroke may be caused. The body must be exposed bit by bit, and for a gradually increasing period: the feet first, then the legs, then the thighs, and so on, for half an hour, for one hour, for two hours, etc., until the whole body may be exposed while the sunlight lasts. The head is protected, and a thin swimming costume worn. The skin takes on a deep tan colour—the deeper the tan the more efficient the treatment will prove. This method can be

FIG. 16.—TREATMENT OF SURGICAL TUBERCULOSIS BY THE SUN.

A. Patient, aged 4½ years, with thirty-four lesions—osteitis, periosteitis, adenitis, numerous fistulæ, advanced tuberculosis of both feet, of the right hand, and left lung, with peritonitis and cachexia.

B. Same patient a year later. Fistulæ healed, and general health entirely reconstituted.

(From Dr. A. Rollier's book, "La Cure de Soleil.")

carried out in a walled garden, or even in a large four-sided lidless box, without offending the too sensitive feelings of inquisitive neighbours.

Treatment of the *localised condition* should be by prolonged fixation in suitable apparatus on rigidly conservative lines. The method of excising the diseased parts by operation has only to be mentioned to be condemned, first, because of the high mortality attending its use, and secondly, because of its crippling after-effects. Where abscesses form and do not subside, they should be treated by aspira-

tion of their contents through healthy skin as often as necessary. They should not be allowed, on the one hand, to burst through the skin, nor, on the other, should they be treated by incision and drainage; for in either case a sinus may develop, which soon becomes infected with septic micro-organisms. Many tuberculous abscesses absorb spontaneously. Thus, in ten cases of Pott's disease which had a psoas abscess present but unopened when first seen, in five the abscess absorbed and disappeared completely without aspiration.

It has been argued that sometimes the contents of a tuberculous abscess are so thick in composition that they will not pass through an aspirating needle, and that therefore an incision must be made to evacuate them. But this thickening of the contents only occurs in abscesses which are absorbing—in fact, nature's way of absorbing them is first to get rid of as much of the liquid contents as possible—and so in these cases aspiration is not required. When one does aspirate, one only does so in order to remove the more fluid contents, and assist nature to solidify and dry up the remainder. To inject fluids into an abscess cavity with the object of liquefying the contents is going against the natural process of cure.

Where the abscess is already discharging through a sinus when the patient comes under treatment, one should on no account interfere with it by operation; a fresh dry dressing of some aseptic absorbent material, gauze or wood wool, should be applied daily, and the sinus left severely alone. If the case is being efficiently treated in other ways, the sinus will heal. Should a piece of dead bone present—an unusual event—it may be removed with forceps; but all raking about inside such a sinus is to be deprecated. It won't hurry the healing process, and it may light up the trouble violently.

Fixation is best carried out by apparatus which allows of easy access to the part, and which does not interfere with the circulation; it is to be worn day and night con-

tinuously. For this purpose, Thomas's splints and Thomas's methods are invaluable.

I propose now to consider in some detail the sites most commonly affected.

1. Tubercular Disease of the Spine ("Pott's Disease," "Spinal Caries").

This occurs chiefly in young children from one to seven years of age, and affects usually the dorsal or lumbar regions; less commonly the cervical region. The symptoms are pain and rigidity of the affected part, inability to stand up straight without holding on to pieces of furniture or other persons for support, irritability of temper, unwillingness to be jolted or shaken, and the presence of a prominent spinous process. Of all the diagnostic symptoms, that of rigidity is the most important; and if this sign be discovered, Pott's disease should be suspected at once. A radiogram will often reveal the presence of gross changes in the bodies of one or more vertebræ. If the case be neglected until marked angular deformity has developed the diagnosis, of course, becomes obvious; but it should be diagnosed long before this has occurred.

Treatment is by fixation in the recumbent position in a "double Thomas's hip-splint with head and feet extensions" (Fig. 17, and Appendix). It is impossible to fix the spine, either by simply putting the patient to bed, or by applying some jacket or back splint and letting the patient walk about. Excepting the arms, fixation of the whole patient—head, neck, trunk, and legs—combined with the recumbent position, is absolutely essential. The patient is put in the splint and carried about like a piece of furniture. The splint should be slightly arched, with convexity upwards, so that when it is laid on a table the two ends touch the table, while the intervening part is clear of it. This serves to counteract the tendency to the formation of angular deformity. The parents may object to the splint on the ground that their child won't like it; but every

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child I have ever seen put in this splint has always experienced such a sense of relief that he has become reconciled to it at once. The splint is not to be removed for any purpose whatever; washing can be carried out perfectly well in it; while for defæcation the chamber is placed beneath the patient, and the two ends of the splint rested on two convenient objects, such as two tin biscuit-boxes. The underclothes are made to fit over the splint, being slit down the front, and closed with tapes. In the house the child is placed on a well-padded couch; outdoors, on a spinal

FIG. 17A.—DOUBLE THOMAS'S HIP-SPLINT WITH ADJUSTABLE HEAD AND FEET EXTENSIONS.

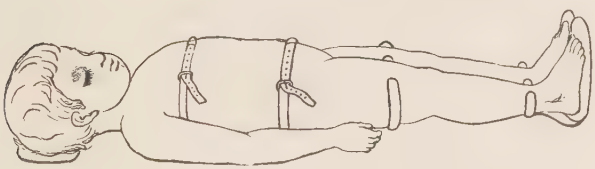


FIG. 17B.—THE SPLINT APPLIED.

The trunk and legs are, in addition, secured with bandages; these are not shown in the figure.

(The figures are from the *Lancet* of July 28, 1888.)

carriage. The length of time the splint must be worn depends on each case; but to be on the safe side, it should be certainly retained for two years. At the end of that time, should the progress of the angular deformity be stationary, and should no complications have arisen, it may be removed, and a Thomas's posterior spinal splint applied in its place, the patient being allowed up and about in it for another two years, after which it may be left off, first at night, then for part, and, finally, for the whole of the day. If the disease has been in the cervical region, a Thomas's collar will be worn instead of the spinal splint.

It is of great importance to record the amount of deformity accurately, so that one can judge of the progress of the case; for if the deformity is on the increase, the case cannot be considered as doing well.

Method.—The patient lies prone on a flat couch, with face turned to right, and arms by the sides (Fig. 18). A tape of block-tin, 24 inches $\times \frac{5}{8}$ inch $\times \frac{1}{16}$ inch, is then moulded along the spine from the seventh cervical spinous process to the beginning of the gluteal cleft, marking on the tape the position of the twelfth dorsal process. A tracing of this is transferred to paper, and forms the record of the deformity. If in a similar tracing made a few months later the kink be sharper, one may be certain the deformity

FIG. 18.—METHOD OF MEASURING DEFORMITY IN POTT'S DISEASE.

has increased. During the treatment of a case this measurement should be made every three months.

Complications which may arise are abscess formation and compression paraplegia.

Abscess.—This is present at some time or other in at least 30 per cent. of the cases. The site depends upon the region of the spine affected. In the upper cervical, it may appear in the posterior wall of the pharynx as a "retropharyngeal abscess," or may burrow out and present behind the sternomastoid muscle. In the upper and mid-dorsal, it may pass backwards and appear as a "lumbar abscess," or track forwards along the ribs as a "costal abscess." In the lower dorsal and lumbar, it may pass backwards as a "lumbar abscess," or more commonly downwards and forwards beneath the fascia covering the

psoas muscle, which fascia is thereby made to bulge, forming a "psoas abscess." The majority of psoas abscesses never leave the abdomen, but a few burrow along and pass out with the psoas muscle, and appear under Poupart's ligament in the thigh. All cases of Pott's disease should be carefully examined for the presence of abscess; especially should the abdomen be palpated for psoas abscess in each iliac fossa, for here it is often overlooked. It is felt as a smooth, rounded, elastic tumour, situated in the outer part of the fossa; it is slightly tender on pressure, and can often be temporarily enlarged by pressing in the abdominal wall above it—that is to say, the sign of fluctuation is present. When the patient coughs, an impulse is transmitted to it. A radiogram will reveal a bulging of the shadow normally cast by the psoas muscle before the abscess is palpable from the abdomen. A radiogram, therefore, should be taken of every case.

When diagnosed the abscess is left alone, the patient, if not already in a double Thomas's splint, being placed in one immediately. With such treatment the abscess usually absorbs spontaneously. If it should continue to get larger and larger, even then it is left alone unless it is in danger of rupturing the skin, when it is aspirated with a Potain's aspirator. If it fill up again it is aspirated again, if need be a dozen times. When the case arrives with an abscess already ruptured, or with a discharging sinus the result of operation, the condition is treated by the application of sterile gauze to the external opening. The exploration and curetting of these sinuses will do no good, and may do great harm. The formation of a sinus always makes the prognosis worse; the mere presence of an abscess, if unopened, is not so bad; but if it should become changed into a discharging sinus, the outlook becomes much more serious.

In aspirating, a needle $\frac{1}{8}$ inch in diameter is used, and is introduced into the abscess through healthy skin, and as obliquely as possible. In many children an anæsthetic may be necessary.

Compression Paraplegia.—If on the first examination the case is found to have symptoms of nerve irritation—*e.g.*, increased knee-jerks and weakness of the legs—treatment by recumbency and fixation will be followed always by disappearance of these symptoms. Even if there be loss of control over bladder and rectum, under this treatment control returns in the course of a few months. In my experience a laminectomy has never been required. Probably the laminectomies performed in the past to relieve compression paraplegia could have been avoided if efficient fixation and rest had been employed. It is of interest to note that neither abscess nor compression paraplegia appear after the double Thomas's splint is applied: they are the signs of inefficient treatment.

Remarks.—After a case has been two years in the double Thomas's splint without complications, and likewise two years in a posterior splint or collar, it becomes desirable to leave these off gradually and strengthen the spinal muscles, which have been prevented so long from doing their proper work. A course of gentle exercises must be instituted, under the daily direction of the surgeon. (See exercises for strengthening spine in lateral curvature.) Albee has of late years introduced an operative method of treating Pott's disease by splitting the spinous processes of the five or six vertebræ involved in the kyphosis, and laying in the bony trough thus formed a bone graft or splint taken from the child's tibia, fixing it there with kangaroo tendon. The graft grows in and fixes the spine at that spot, forming a "bone splint." Albee claims that this does away with the need for an ordinary spinal support, or, at least, very much lessens the time during which it need be worn. This may be so, but the mortality of the operation is not low, and I have yet to be convinced of its advantage over the method by fixation and recumbency.

2. Hip-Joint Disease ("Hip Disease," "Tubercular Hip").

This also affects children, but of a slightly higher age period. The early symptoms are a slight limp and pain complained of in the knee, made worse by walking. On examination, the muscles of the thigh and buttock are found slightly wasted, and on testing the movements of the joint there is slight limitation of movement in some or all directions. There is nearly always some fixed flexion—*i.e.*, the thigh cannot be completely extended. This fixed flexion, when small in amount, is often missed, as the pelvis tilts

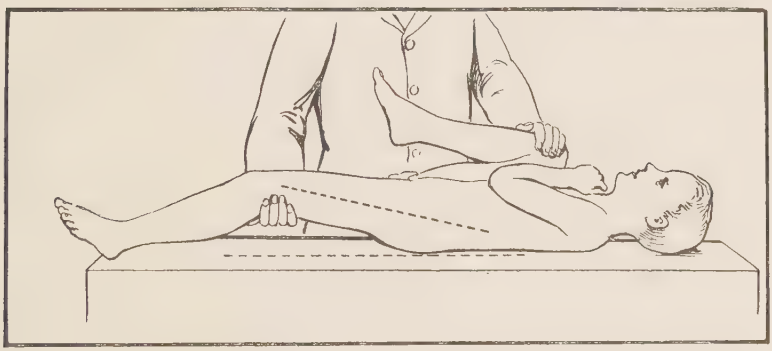


Fig. 19.

forwards on a transverse axis to compensate for it, producing slight lumbar lordosis. In order to ascertain if this fixed flexion be present, Thomas devised a plan which has been known since as "Thomas's test" (Fig. 19). The patient having been undressed and laid on a table, the surgeon takes the sound limb and flexes it until the lumbar lordosis is obliterated, and the whole spine lies in contact with the table. The hands of an assistant or of the patient himself maintain the sound limb in this position, while the patient is urged to extend as far as he is able the diseased limb. According to the stage reached by the disease, the affected limb will be at a greater or less

angle with the table, and the number of degrees in this angle will be the measure of the amount of "fixed flexion." This flexion is due to protective spasm in the psoas muscle, and does not disappear when the patient is anæsthetised.

It is perhaps necessary to point out that these symptoms —limp, pain, wasting, limitation of movement—are the symptoms of simple synovitis of the hip-joint, but as in the very large majority of cases they prove to be of tubercular origin, they are, when discovered, diagnosed as tuberculous. Now and then rare cases turn up which may not be tubercular, but to err on the safe side they had better be treated as such.

Other signs which have been emphasised by past writers are "apparent lengthening of the limb," and "lowering, or obliteration, of the gluteal fold," both of which, if not explained, are apt to lead to a confusion of ideas. The former is due to slight abduction of the thigh, which is done unconsciously to ease the joint; and to enable the patient to walk with the thigh in this position, the pelvis must tilt down on that side, giving the appearance of apparent lengthening. The latter is due to the flexion of the thigh, and to nothing else. Any healthy person standing with one thigh slightly flexed will exhibit an obliteration or lowering of the gluteal fold on that side.

If the case is only seen after the trouble has been present many months, or if the case has run a very rapid course, the symptoms become aggravated, and other signs will be present—viz., marked flexion, marked wasting, marked limitation of movement, apparent or even actual shortening, adduction, and pain in the hip-joint itself, which is worse at night. While the muscles are on guard during the day the pain is not so bad, but at night, when the child drops off to sleep, the muscles relax somewhat, the inflamed joint surfaces move on each other, and the pain caused wakes the child with a cry. This is known as "night-starting." In an advanced stage, an abscess may have formed and sinuses be present.

The **treatment** should be immediate fixation in a single Thomas's hip-splint (Fig. 20, and Appendix). After the splint has been applied the child should remain a few days in bed until it gets quite used to it. These few days are spent in overcoming the fixed flexion; for the splint is applied quite straight—that is, with the trunk portion and leg portion parallel to each other. At first, owing to the flexion, the splint does not quite fit; but after a few days, usually two, the flexion disappears, and the limb sinks down into it and a perfect fit is obtained. The parents are warned that the first couple of nights may not be very comfortable. Some surgeons, unfortunately, do not know that the splint should be applied with the two parts of it parallel, and flex the lower part on the upper to correspond with the flexion of the patient's limb. When the splint is removed after a year or two, the fixed flexion remains as a permanent deformity, with compensatory lumbar lordosis.

Fig. 20.—Thomas's Hip-Splint for Left Hip, with Abduction Wing.

If the symptoms have been very acute, with much pain, it will be necessary to keep the child in bed in the splint for several weeks to allow them to subside. When the child is allowed up, the boot of the sound limb is fitted with a 2-inch patten (Fig. 21), and he walks with crutches, letting the diseased limb hang. The splint is worn day and night until the surgeon is satisfied that all disease is long ago healed. This is not, as a rule, until twelve or eighteen months have passed from the date when the patient felt no more pain. If an abscess form, the period of fixation will have to be much longer. The complication of abscess does not occur in my experience nearly so frequently in hip disease as in tuberculosis of the spine. When it does occur, a fluctuating swelling

forms on the outer aspect of the thigh over the great trochanter.

Treatment should be by aspiration, just as in Pott's disease.

In deciding that the disease is healed, and that it is safe to begin allowing the child to come out of the splint, one is guided chiefly by the absence of pain on movement, and by the absence of muscular spasm. If the hip-joint can be painlessly manipulated to a considerable degree in all directions, without setting up any spasm, the probability is that the condition is cured.

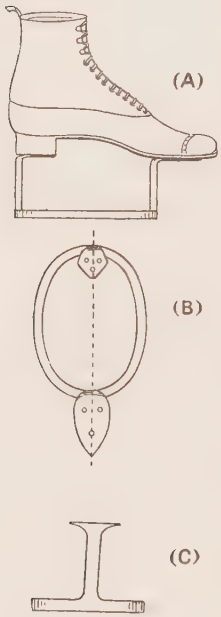


FIG. 21.—THOMAS'S PATTEN.

A. Side view of patten for left boot.
B. Same patten seen from above.
C. Ditto, seen from in front.
(Note the slant of the upright stems to prevent tendency to valgus.)

Diagnosis.—In doubtful cases of hip disease much help may be gained by radiographic examination, provided the trouble has lasted a few months. A fluffy appearance of the head of the femur and of the acetabulum is noticed, and erosion of the bones, specially the latter. If the case has been going on slowly for years, there may be absorption of bone at the upper margin of the acetabulum where the pressure comes, with corresponding deposition of new bone at the lower margin; so that the acetabulum has gradually moved up towards the anterior superior spine, producing the condition of "travelling acetabulum." Several conditions may be mistaken for tubercular hip, but the true nature of the case will often be revealed by the radiogram, apart from other considerations. These conditions are: tubercular disease of sacro-iliac joint; congenital dislocation of hip; Calve's "pseudo-coxalgia," in which the upper epiphysis of the femur is flattened; partial separation of the upper epiphysis, causing coxa vara; and

"hysterical hip." In the latter trouble the radiogram is normal, the symptoms are contradictory, and the limitation of movement is only apparent, and can be overcome by gentle persuasive manipulation, or by giving an anæsthetic.

3. Tubercular Disease of Knee-Joint ("Tumor Albus").

In no part of the body has the treatment by excision of the diseased joint been more strongly recommended than in the knee, and attended with more frightful results. The effects of excising a tuberculous knee-joint in a child, even suppose he survive it, is to produce at best a stiff limb 4 to 6 inches shorter than the other. But frequently the limb bends at the site of the operation, through insufficiently prolonged application of splints, and a re-excision has to be done to get the limb straight, producing still further shortening of two or more inches. Not content with merely excising the joint, some surgeons have advocated forcibly tearing out the lower epiphysis of the femur in cases where the disease has begun in that bone, and apparently regard with perfect complacency a direct mortality from the operation of 10 per cent. Yet treatment on conservative lines will often give a movable joint; and if it does not, one can at least be sure that the limb will be straight and of normal, or nearly normal, length. The advocates of excision claim that the shortening of the limb caused by their operation is an advantage, because if the limb is to be stiff it is easier to walk with it short than long. But they ignore the fact that the shorter the limb the worse the limp, and the more unsightly the deformity. Wear a high boot, they say!

One other claim is made by the excisionists: that operation gets rid of the disease much quicker than any other way. Perhaps it does; but it does not shorten the period required for treatment, because if the limb be not kept in a splint for years after the excision it will surely bend at the site of operation. Excision should never be done in children.

It may occasionally be justifiable in adults, after prolonged treatment by fixation has failed; but the aphorism of Thomas on this matter holds good for practically all cases: "if a tubercular joint is bad enough to excise, it is bad enough to amputate." Conservative treatment in adult cases should be persisted in even when progress is slow, and operative treatment, such as excision or amputation, only employed when the patient is going down-hill or where the pain is unbearable. Of the two alternatives, amputation is preferable.

The disease may start in the bones forming the joint, or in the synovial membrane; but, whichever it is, the whole joint soon becomes involved in a purulent synovitis. The symptoms are pain and stiffness in the knee, causing a limp, occurring usually in a child, attended by heat and swelling. They may follow an injury, or develop gradually without apparent cause. At first the symptoms may be slight and intermittent, and they may be attributed to "rheumatism" or a slight muscular strain. But gradually they increase in intensity, and eventually produce an unmistakable picture. The swelling of the knee is characteristic: all the bony outlines become lost in a pale fusiform tumour, the "tumor albus," of doughy consistency. The swelling is not limited, as in simple synovitis, to the capsule, but shades off gradually into the thigh and leg. The joint becomes distended with purulent fluid, acutely tender, and all movement of it painful. Flexion occurs, and later on the tibia slips back on the condyles of the femur, due to softening and disorganisation of the crucial ligaments, making the front of the knee unduly prominent; also, owing to spasm of the biceps, outward rotation of the tibia on the femur is produced. These three alterations, the flexion, the slipping back, and the outward rotation, constitute what is known as the "triple displacement" deformity. Sooner or later, if not treated, the skin and underlying tissues give way at some spot, and a sinus forms. This becomes infected with septic organisms, septic infection of the whole joint takes place, and the patient may die

from exhaustion. If the onset be arrested by efficient treatment, the acute symptoms will subside gradually, and a useful limb will be eventually obtained; if the case is got early, one will hope confidently for movement to be completely restored. The X-ray appearances are similar to those of tubercular disease elsewhere: in early cases a fuzziness of the bones will be the only sign discernible; but, later on, absorption of cartilage with underlying necrotic areas will be noticed. The disease has a pronounced effect on the patient's well-being: he becomes irritable and restless, and suffers from loss of appetite and malaise.

Diagnosis.—A synovitis of the knee-joint in a child which does not clear up under ordinary treatment after several weeks, and for which no cause, such as displaced cartilage or loose body, can be found, must always be regarded with suspicion. A radiogram should be taken at once, and if negative, repeated at intervals of a month. If there be any likelihood of the trouble being tubercular, it should be treated as if it were, by continuous fixation. No harm will result from keeping the knee stiff, whereas great harm may result from allowing it to be moved. Though many conditions may be mistaken for it, the pale, fusiform, painful, pulpy swelling of a well-marked case can hardly be confused with anything else. Such conditions are:

1. *Simple Traumatic Synovitis.*—The capsule and subcrural pouch are distended with fluid, which rapidly subsides under treatment by rest, elevation, and elastic pressure.

2. *Inflammation of Subpatellar Pad of Fat.*—The swelling does not involve the capsule, but is limited to an area on either side of the ligamentum patellæ.

3. *Displacement of Semilunar Cartilage and Loose Body in Joint.*—A definite history "of locking" is obtained.

4. *Rheumatoid Arthritis.*—A history of acute attacks is often obtained in this and other joints; radiography reveals "lipping" and osteophytic formation.

5. *Hæmophilia.*—Effusion into the knee-joints is common in hæmophilia, and is usually bilateral. The parents mention that the child is a bleeder, and the radiogram

shows the shadow cast by effused blood, and perhaps "lipping" of the edges of the bones and absorption of cartilage.

6. *Sarcoma of Lower End of Femur, or Head of Tibia.*—The swelling involves either the upper or lower half of the knee, and a radiogram shows the presence of the tumour and expansion of the bone, with perhaps radiating spicules.

7. *Acute Osteomyelitis of these Bones.*—The symptoms come on very acutely; there is high temperature; the condition is so painful the child will hardly let you approach the bed.

8. *Suppuration of Popliteal Glands.*—The swelling is chiefly behind the knee, and there is pain on pressure, and œdema there.

9. *Gonococcal Infection.*—There is or has been a urethral discharge; other joints are frequently affected; an acute condition causing distension of the capsule. Cultures taken from the fluid obtained by aspiration show the gonococcus.

10. *Syphilitic Infection, Congenital.*—A bilateral synovitis, frequently disappearing and recurring. Other syphilitic manifestations present—*e.g.*, keratitis.

11. *Pneumococcal Infection.*—Acute distension of the capsule with purulent fluid; cultures made with the aspirated fluid show the pneumococcus; there may be pneumococcal abscesses in various parts of the body at the same time. Usually clears up if efficiently treated by fixation and aspiration; occasionally a large portion of the condylar margin becomes necrosed, with limitation of movement.

Treatment.—Fixation in a Thomas's knee walking-splint is indicated, with patten beneath sound foot, and crutches (Fig. 22, and Appendix). If there be much pain, a few weeks' rest in bed in the splint will abolish it before the patient is allowed up and about. Fixation must be maintained uninterruptedly day and night, as in the case of the hip and spine, until the surgeon believes all active trouble arrested. He will be led to this conclusion by disappearance of swelling, pain, and heat in the joint. It is better to err on the safe side, and keep splint on for too long rather than

for too short a period. When cure seems likely, exchange splint for a calliper knee walking-splint (same splint can be used if cut off at correct level and ends bent inwards to fit in tube in boot-heel), and let patient get about without crutches. If still no swelling, pain, or heat, leave off splint altogether after six months. Nothing is more trying to patient, parents, and doctor, than for the latter to remove splint too soon, and cause all the symptoms to return; everyone feels that the time so far spent in treatment has been wasted, and the doctor does not have an easy time explaining the misfortune.

When the splint is finally removed, there may be little or no movement in the joint; but gradually with use the function returns. On no account must the knee be forcibly manipulated; this might have the effect of starting off the trouble all over again. Leave the knee alone, and let the patient be thankful he has got a limb at all. If abscesses develop, treat them as already described for the spine and hip: aspirate, and then leave alone. When a case comes riddled with sinuses, place it in a splint, and do not interfere with them. If, however, one or more flare up, with localised signs of acute inflammation round about them, it is advisable to slit them open widely, and remove the retained discharge and débris which

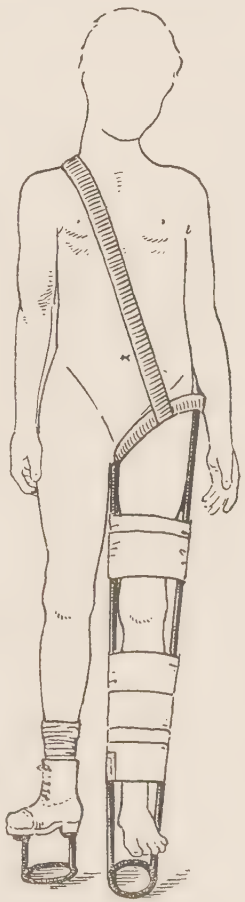


FIG. 22.—THOMAS'S WALKING KNEE-SPLINT.

Measurements.—State right or left; horizontal circumference of thigh at perineum; length from perineum to heel; tracing of leg. Order patten at same time, sending boot of sound side to have it fixed.

is causing the acute symptoms. Where the whole joint has become disorganised, where no improvement is taking place, where, owing to the great pain, the patient is going downhill rapidly, amputation well above the subcrural pouch is the proper treatment to advise. If he refuses, excision may be offered in its place, but it frequently ends in amputation, and may set up acute miliary tuberculosis and cost the patient his life.

Note.—Where flexion deformity is present, it must be got rid of in the splint during the first few days in bed. Extension strapping is applied to the leg, and tied tightly to the end of the splint. The lower part of thigh and upper part of leg are bandaged tightly to the splint with a broad bandage. By next day the knee will have given a little, and the extension strapping and the bandage will both be loose and require tightening. Next day they are loose again, the knee having straightened still more, and they are tightened as before, and so on, until after a week the knee has come down quite straight. The pull on the leg and the pressure on the thigh and leg soon overcome the spasm of the hamstrings.

4. Tubercular Disease of Ankle and Foot.

This may start in the ankle-joint itself as the result of a sprain, or more commonly in one of the tarsal bones, especially the astragulus, thereafter spreading to the neighbouring articulations. In a marked case a pale, fusiform, pulpy swelling masks the ankle-joint similar to that seen in the knee; the foot is kept in a dropped position, and all movement is very painful. Abscess formation with sinuses is frequent, and one is much tempted to operate on the (apparently) localised foci to eradicate them. But only very rarely is this possible; more often the operation does no good, and the sinuses do not heal. In diagnosis, radiography is invaluable. One sometimes meets with cases, however, where the ankle swells up repeatedly with use and subsides with rest, but where the radiogram is

negative. Such cases are probably early tubercular ones, and should be treated as such. One does not want to wait until an abscess forms to make the diagnosis.

Treatment consists in placing the foot at rest. No movement must be allowed in the ankle or tarsal joints, and no pressure be transmitted through them. The foot should be placed in a right-angled tin night-shoe; if the foot is already in the dropped position, this splint cannot at first be used, and a Thomas's club-foot splint must be employed instead (Fig. 23), the angle of the heel-piece being opened out to accommodate itself to the foot. Each week this angle can be slightly diminished, bringing the foot with it, until it lies eventually at right angles; the tin night-shoe can then be substituted for it. If the disease is in an active state, it will not take many weeks to bring the foot to a right angle; but if it has been going on for years, permanent shortening will have taken place in the tendo Achillis, and it will not be possible to bring the foot into the ideal position without doing a tendon-lengthening operation. The object of the ideal position is to get a useful foot for walking. Many of these cases end with more or less stiffness of the tarsal and ankle joints, if not with actual ankylosis. Such stiffness or ankylosis is not such a great disability if it occur with the foot at right angles to the leg; but if it occur with the foot in the dorsiflexed, or, still worse, the plantar-flexed, position, the disability is very much more serious.

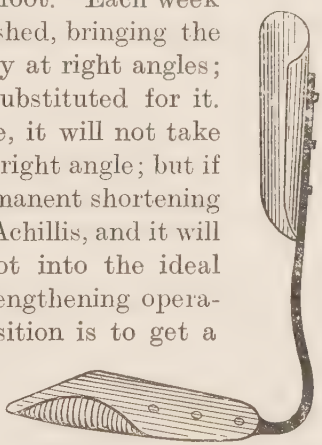


Fig. 23.—Thomas's Club-Foot Splint for the Right Foot.

This fixation of the foot will afford sufficient treatment if the patient is willing to hop about with crutches, keeping the knee bent so as to clear the ground. But if he be not willing to use crutches, a Thomas's knee walking-splint can be applied in addition, with a patten beneath the sound foot; and the patient can then walk about when once he has learnt to balance himself. For the sunshine treatment

the bandages are removed, and the parts exposed to the sun while lying in the splint, but without taking it off.

These splints must be retained until all signs of inflammation have been long gone, and until all signs of active bone trouble have disappeared from the radiograms. If abscesses develop, they should be aspirated; no good will be done by introducing sharp spoons and scraping their interior. The only exception to this is where the sinuses flare up, as described in the knee; this flare up is due to secondary infection with septic organism, and is best treated by slitting open the sinus to improve the drainage.

At first, until the condition is obviously improving, the patient should not be allowed up; the limb should be kept horizontal; only later is ambulant treatment with crutches or with the Thomas's knee-splint permitted.

5. Tubercular Disease of Shoulder-Joint.

Just as in the hip and knee, here, again, the early signs are stiffness and pain and muscular wasting, with radiographic changes in the bones. If abscess forms, it points either in front or behind, at the inner side of the joint. The symptoms must be distinguished from those of *simple traumatic synovitis* of shoulder-joint, which condition, for some unaccountable reason, is not described in textbooks on surgery. The symptoms of this simple synovitis come on after a fall on the shoulder, or after a wrench, and may be divided into three groups:

1. A dull aching pain in the shoulder, which is always worse at night, keeping the patient awake. He may go to sleep all right, but he soon wakes up because of the pain; he drops off to sleep, and again wakes up; and so on through the night; moreover, he is quite unable to lie on the injured side. The pain is increased by movement.

2. The presence of spots acutely tender on pressure. One is just beneath the tip of the coracoid process, in the infraclavicular fossa; and the other just anterior to the insertion

of the deltoid into the humerus—*i.e.*, over the lower part of the bicipital groove.

3. Inability to abduct the arm, as in putting one's arm into one's coat-sleeve, or to rotate it inwards, as in scratching one's back.

No swelling of the joint cavity due to distension with synovial fluid is noticed; the fluid apparently escapes away down the synovial sheath of the biceps tendon into the tissues of the arm, and is rapidly absorbed. This explanation will also account for the acutely tender spot which is present over the lower part of the bicipital groove; for when the synovial membrane of the joint is inflamed, the sheath of the biceps tendon must also be affected.

These symptoms may persist for many months if not treated by absolute rest. They are usually only very imperfectly recognised, and are regarded as being due to osteo-arthritis of the shoulder-joint, or to inflammation of the subacromial bursa; and they are treated by massage and movements, with the result that the trouble may last for months or even years; occasionally the repeated passive movements cause abscess formation in the joint, with subsequent ankylosis. The condition is much aggravated by the daily dressing and undressing, and putting the arm into the sleeve of vest, shirt, and coat is much dreaded by the patient.

Fortunately for him, he soon learns that movement makes him worse, and he gives it up, and slowly gets well without the aid of medical skill (*sic*). In this he is helped by the fact that it is comparatively easy for him to put the shoulder-joint at rest, even when going about his work.

Treatment of Simple Traumatic Synovitis of Shoulder-Joint consists of immobilisation of the joint. This is done by using the Thomas's sling to support the wrist, and fixing the arm to the trunk with strapping. A single strip, 3 inches wide, is taken once round the upper part of the arm which is hanging down by the side, and then carried across the posterior outlet of the axilla to the skin over the scapula, reaching as far as the vertebral spinous processes.

The "Thomas's sling" method (Fig. 24) consists in slinging the wrist to the neck beneath the clothing. A 4 inches wide flannel bandage, 3 yards long, is knotted fairly closely round the neck, with the two ends hanging down equally. Where these two ends come opposite the upper border of the wrist, the elbow being flexed to less than a right angle, another knot is made, and one end passed in front of the wrist and one behind it. The wrist is pushed up snugly against the knot, and the end which passed

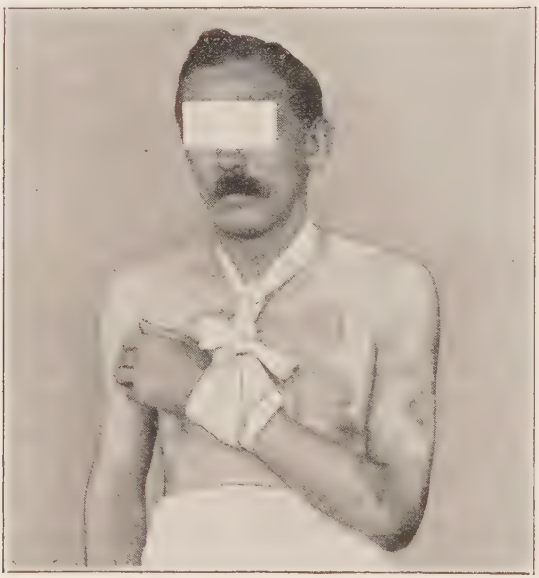


Fig. 24.—Thomas's Sling.

in front is turned up behind, and the end which passed down behind is turned up in front, and the two tied above the wrist again in a third knot. Some wool is introduced between the bandage and the wrist to prevent chafing.

This sling very much limits the movement in the shoulder, and gets the limb out of the way. The addition of the strapping, applied as described, completely immobilises it, the trunk acting as a natural splint. The shoulder is to be kept immobilised until the tender spots are no longer tender,

till the pain during the day is gone, and till the patient is able to sleep all night on the affected side without being waked by pain. This takes from two weeks to three months, depending on the case. The sling is then removed, and the patient allowed to put his arm in the sleeve of his clothes, the wrist being supported in an ordinary sling for another fortnight or month. In dressing, the injured arm must be put into the sleeve of each garment before the sound arm; and in undressing, the sound arm must be taken out of its sleeve before the injured one.

When the limb is finally removed from all restraint there will be some stiffness, which will gradually wear off in the course of time. No massage and no movements are used during the treatment, but the patient is told to move his wrist and fingers frequently to keep them comfortable.

Tubercular disease of the shoulder-joint exhibits all these symptoms, and others as well, such as marked muscular wasting, blurring of the radiographic picture, perhaps with signs of necrosis, and general constitutional symptoms, such as anorexia, irritability, and pyrexia. Then, again, tuberculosis occurs much more frequently in young people, whereas synovitis of the shoulder occurs chiefly in adults. If the two conditions are borne in mind, a mistaken diagnosis is not likely.

The treatment of tubercular shoulder is carried out in exactly the same way as for synovitis, with this difference that the sling must be worn for one or two years, and that every three or six months a radiogram is taken to observe bony changes. When all symptoms, objective and subjective, have disappeared, it will be safe to take the limb from the sling, and allow the patient to put his arm in his sleeve, still wearing a sling over his clothes. If after another six months all is well, and there has been no return of symptoms, the case may be regarded as cured. The result in most cases will be a freely movable joint.

6. Tubercular Disease of the Elbow-Joint.

Here, again, the condition has to be diagnosed from simple traumatic synovitis. The latter trouble follows a severe sprain or partial or complete dislocation, and is kept up and aggravated by injudicious, "pump-handling" passive movements, carried out in all good faith by the unknowing surgeon. In a typical case, the elbow is kept at an angle of 120 degrees; all passive movements are painful, and are resisted by the patient; the whole elbow is hot, tender, and swollen, and there may be œdema and bruising. If the limb be suitably immobilised for a few days, these symptoms rapidly subside. The method used is the same as for the shoulder, the "Thomas's sling." (It may be noted here that, beside being the best method of treatment for inflammation of the shoulder and elbow joints, the Thomas's sling is also an extraordinarily satisfactory means of treating all fractures of the humerus, whether simple or compound.)

In applying the Thomas's sling for treatment of the elbow-joint, we want to get the elbow flexed to a suitable angle, and keep it there. The best angle is 45 degrees, with the forearm in the mid-position between pronation and supination. If the elbow is held rigidly extended at 120 degrees, it will not be possible on the day the sling is applied to lessen that angle. So the sling is put on with the elbow still at an angle of 120 degrees; but each day, as spasm subsides, the elbow can be flexed a little more and the sling adjusted, until, after four or five days, the desired angle is obtained. The limb is then kept in the sling until all the symptoms of inflammation have disappeared, which will usually be in two or three weeks' time. If the limb be taken out too soon a relapse occurs, and the symptoms return. In order to prevent this unfortunate occurrence, Thomas devised a test, by which it is possible to tell if a cure has been brought about, and if it is safe to use the limb. The test consists in removing the sling, and observing if the patient of his own free will can alternately

diminish and enlarge the angle at which his limb has been kept during treatment; if he can flex it still more and bring it back to the angle of treatment, then extend it beyond the angle of treatment and bring it back again, cure has been obtained, and the patient may use his limb without fear of relapse (Thomas, Part III., 1887, p. 95). If he cannot do this, a further period of treatment in the sling is necessary.

If the case has not been treated by rest, but by constant manipulation, which has aggravated the condition, then, even when the proper treatment by fixation has begun, not weeks, but many months may elapse before cure is complete.

In *tubercular elbow*, which may have come on gradually without apparent cause, or may have followed an injury, especially if this has been wrongly treated, a fuzziness of the bones of the joint is nearly always observed in the radiogram; there is a doughy swelling of the whole joint, due rather to softening and swelling of the capsule than to œdema of the skin, and there are the signs of constitutional disturbance, malaise, and irritability, the usual accompaniments of the disease. Abscesses may form about the joint; if they do, they should be left alone as long as possible, and then aspirated through healthy skin. If a sinus form, the discharge must be absorbed in antiseptic dressings freshly applied every day.

Treatment of the joint is carried out in the Thomas's sling with the elbow at an angle of 45 degrees. This angle has been decided upon "because it is advisable to place the limb which is under treatment in such a position that of the muscles controlling the part the weaker should be favoured; because experience shows that this position is the one from which limbs after perfect cure are sooner able to perform their duty; and because, if ankylosis should remain to lessen the value of the cure, an elbow-joint fixed at an angle of 45 degrees gives the limb the greatest possible degree of usefulness, minimising a defect. The selection of an angle some few degrees less than the right

angle would be only *inclining* in the right direction" (Thomas, Part III., p. 107).

This sling will be worn for from one to two years, or even longer. When the surgeon thinks it is safe to remove it, he will allow the patient to use his arm to a limited extent only for the first few weeks, and then carefully examine it to see if there be any return of symptoms; if there are none, he will allow still further freedom, checking the state of the elbow by frequent examinations, until he is able to announce that cure is certain.

Excision of the elbow for tubercular disease is an operation which can hardly ever be necessary: fixation in the sling will cure practically all cases. Excision has been practised on cases which have done badly after frequent incisions and scrapings, and applications of plaster of Paris bandages; but if these methods had not been employed the condition would have never reached the stage calling for an excision. The frequent incisions and scrapings only stir up the disease and tend to perpetuate it; and the plaster of Paris bandages, while only partly fixing the joint, have the great disadvantage of causing pressure on the part, impeding its circulation, and shutting out the curative influences of light and air.

Even the most hopeless-looking cases do well when at last properly fixed in the sling.

7. Tubercular Disease of Wrist-Joint.

This starts frequently in the tendon sheaths on the back or front of the wrist, spreading then to the joints beneath. There is heat, and pain, and stiffness of the wrist, which tends to fall into the dropped position, a flattened fluctuating swelling over the course of the tendons, and inability to use the hand for lifting anything. Sometimes the tendon sheaths are affected, both in the palm and in the forearm, and one is able to obtain fluctuation through from one to the other beneath the anterior annular ligament. When

the bones become affected, the radiogram shows these to have the usual fuzzy appearance.

Treatment is exceedingly simple, and consists of placing the hand, wrist, and forearm in a dorsiflexed wrist-splint (Fig. 25), and keeping it there until all symptoms have gone, which will take from nine months to two years. While in the splint, the hand, wrist, and fingers may be used

FIG. 25.—DORSIFLEXED WRIST-SPLINT.
The limb is bandaged into this.

to the extent allowed by the splint, but the latter must not be removed day or night, and at first, until cure is well advanced, the limb must be supported in a sling. If the fluctuating swellings increase in size, the contents should be removed by aspiration or by "delayed incision"—that is, waiting until they have almost burst through the skin: all extirpative operative treatment is absolutely contra-indicated.

CHAPTER VI

DEFORMITIES ACQUIRED AFTER BIRTH

D. Due to Habit, Clothing, or too rapid Growth.

1. Lateral Curvature of the Spine (Scoliosis), Stoop, and Round Shoulders.

THOUGH stoop and round shoulders may occur as separate conditions, they lead on very frequently to lateral curvature of the spine, and are found accompanying it almost invariably. It is therefore convenient to consider them along with lateral curvature, especially as the treatment of them is carried out on similar lines.

General Causes.—The cause of these conditions is a weakness of the whole of the structures of the body, bones, muscles, ligaments, etc., a condition which is aptly described by the term *skeletal insufficiency*, combined in the majority of cases with long-continued sitting and standing in stooping or relaxed positions, such as standing on one leg, sitting writing or reading or sewing with the trunk twisted to one side, or with the thighs crossed. The position of writing as generally practised is specially to be blamed; and rapid growth and unsuitable clothing are contributory causes.

Definition.—Lateral curvature of the spine, or scoliosis, is a deformity characterised by lateral deviation and rotation of the spinal column, accompanied, as a rule, by exaggeration of the normal antero-posterior curves. It is important to speak of this condition as lateral curvature, and not simply as curvature, in order to avoid confusion with Pott's disease, in which the angular deformity is unfortunately also referred to as curvature.

Varieties and Degrees of Lateral Curvature and their Classification.—The cases are divided into two groups, the *postural* and the *structural*. It must be emphasised that in the structural cases, as in most acquired deformities, much of the deformity may be postural. In all cases the deformity begins as a postural one, and only after it has persisted for some time is structural deformity produced by it.

The Structural Changes Produced.—The first change noticed is that the *intervertebral disc* becomes wedge-

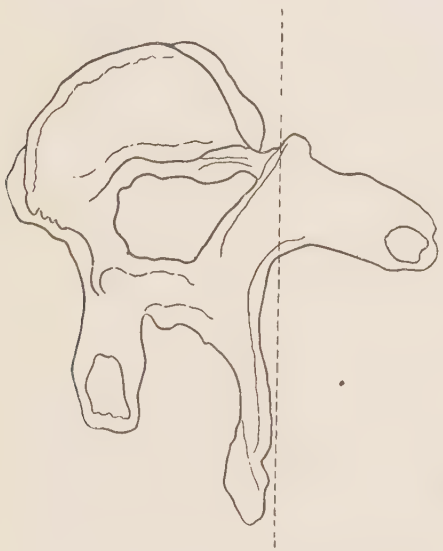


Fig. 26.—Scoliotic Vertebra (Mid-Dorsal Region).

shaped; the same thing then occurs in the *vertebral body*, the apex of the wedge being directed towards the side of the concavity. The wedge shape is due to atrophy from pressure. This atrophy also occurs in the pedicles, laminæ, and articular and transverse processes.

As time goes on, the *transverse process* on the side of the convexity projects more and more backwards (Fig. 26), and less and less outwards, the transverse process on the side of the concavity projecting more and more forwards.

The *vertebral aperture* becomes altered in shape. In the normal dorsal vertebra it is round like a circle; in the scoliotic one it is egg-shaped, the broad pole of the ovoid corresponding to the convexity. The *spinous processes* are deviated away from the middle line on the side of the convexity, but in twisting they lag behind, so that the tip of the process may actually point towards the side of the concavity. Thus a very severe rotation of the vertebral bodies takes place while still the tips of the spinous processes appear very little displaced from the middle line. In addition, remarkable changes are to be observed in the *bony structure* of the bodies. The body of a vertebra consists of an upper and a lower plate, and a ring of hard bone surrounding central spongy bone. The arch is attached chiefly to the upper plate. When torsion takes place, the upper plate with the arch is twisted on the lower plate, so that the bony fibres or spicules which normally pass vertically between the upper and lower plates come to pass obliquely. *The torsion of the scoliotic vertebral column therefore takes place in the osseous tissues of the vertebral column itself.*

Changes in the Ribs.— Owing to the lateral flexion, the ribs on the concave side get pressed together, and those on the convex side get wider apart. Owing to the rotation, as already stated, the transverse process on the convex side is directed more backward. As the vertebral end of the rib is attached to the transverse process, it must follow it, and so the angle of the rib is made sharper on the convex side. On the concave side the opposite occurs: the transverse process is directed more forwards, and carries the vertebral end of the rib with it; thus the angle is flattened out. In front, the same bulging and flattening are produced, but on opposite sides. Thus, if the right ribs are prominent behind, the left ribs are prominent in front. The bulging of the ribs on one side behind causes the scapula on that side to project more than the other; the bulging of the ribs in front causes the breast on that side to project more than the other; and often what first calls a parent's

attention to a lateral curvature is a prominence of one shoulder-blade or of one breast.

Changes in the Loin.—A bulging of the erector spinæ is found in the lumbar region on the convex side, caused by the projection backwards of the transverse processes; on the concave side there is a flattening.

Changes in the Chest.—In consequence of the changes in the ribs, the whole shape of the chest is altered. The diagonal diameter from, say, the right ribs behind to the left ribs in front—*i.e.*, from the bulge behind to the bulge in front—is increased; and the corresponding one on the other side—*i.e.*, from the flattening behind to the flattening in front—is diminished. The chest capacity is diminished, especially the half on the convex side; for the ribs, being more sharply curved, surround a smaller area. On the concave side, the ribs being less curved, the area is greater, but here the height is considerably lessened. Thus diminished lung capacity is one of the serious effects of lateral curvature.

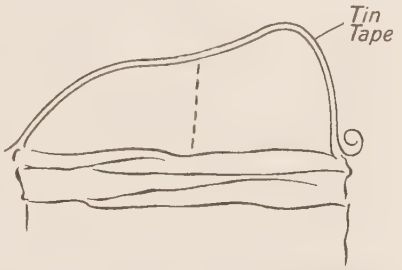


FIG. 27.—RECOGNITION OF STRUCTURAL DEFORMITY.

A patient with S scoliosis, standing with spine fully flexed, seen from behind. The right ribs project posteriorly, revealing the presence of severe structural deformity.

Changes in the Ligaments and Muscles.—These take part in the lateral flexion and twisting, and accommodate themselves to the changes in the bones and cartilages.

When there is structural deformity, its existence is recognised by the fact that when the patient completely flexes the spine (Fig. 27), instead of the two halves of the trunk on either side of the spinous processes being equal, one or other is seen to be more prominent. The amount of this prominence is taken as a measure of the *degree* of structural deformity present, and is described as being slight, moderate, severe, or extreme. If the deformity, with the spine completely flexed and viewed from behind,

is only just enough to be noticed at all, it is described as slight; if it is easily seen, as moderate; if it be so marked as to be obvious to the untrained eye, as severe; while the very worst cases of all are described as extreme.

Six *varieties* of deformity are met with, viewing the spine from behind.

		Graphic Sign.	*Percentage Occurrence.*
	1. Whole spine convex to left	C	54
Double curves.	2. Upper curve to right, lower to left ..	ƨ	31
	3. Upper curve to left, lower to right ..	S	6
	4. Whole spine convex to right	Ɔ	6
Triple curves.	5. Highest curve to left, middle to right, lowest to left	ƹ	2·4
	6. Highest curve to right, middle to left, lowest to right	ƺ	0·4

One often hears a case described as serious "because there are two curves"; but this is confusing the variety of the curve with its severity, an altogether different matter.

Examination of the Patient—1. *The Legs.*—Difference in the length of the legs is best examined for by placing the thumbs on the anterior superior spinous processes, with the patient standing facing the surgeon, with both feet together and knees straight; if both thumbs appear to the eye to be on the same level, the legs are of equal length. If they appear at different levels, the legs must be measured with the patient lying down in the ordinary way. If the legs are then found unequal, a block of sufficient thickness must be placed beneath the foot of the shorter limb to make the pelvis level before proceeding with the examination.

2. *The Spine.*—The patient is stripped right down to expose the iliac crests; the clothes are prevented from slipping down further by the use of a large safety-pin. The hair is coiled up on to the head out of the way.

(*a*) From *behind :* One first takes a general view, observing the "habitual position" of the patient, and noting if one or more signs of lateral curvature are present. These are: an elevation of one shoulder, an enlargement of one arm space (the space between the trunk and the arm as it hangs down), a prominence of one hip; the line of the spinous processes may not be straight, one scapula may project back more than the other, and the whole upper part of the trunk may be situated slightly to the right or slightly to the left of the lower part, when it is said to "overhang" to the right or left respectively. If one is doubtful as to the presence of a sign, thinking perhaps it is caused "by the way the patient is standing," one asks the patient to shift her position for a moment, or to extend her arms fully upward or outward, and then again to stand as before; if the sign is still noticeable, it probably really exists.

Having made these preliminary observations, the patient, standing with feet together and knees straight, is made to completely flex the spine, the head and arms hanging down limply. If the surgeon then examine the "horizon" of the back (Fig. 27) from different levels, and from in front as well as from behind, he will at once notice any structural deformity: the ribs in the dorsal region, or the erector spinæ in the lumbar region, will project more on one side than on the other, due to rotation of the bodies of the vertebræ. If there is no such projection, the case can only be one of postural lateral curvature; if there be projection, the case is one of structural lateral curvature, and the amount of it is at once recorded by using a malleable tin tape, the same as that used for recording the angular deformity of Pott's disease. This is moulded transversely across the ribs posteriorly from the lower angle of one scapula to the lower angle of the other, and also across the loins midway between the twelfth ribs and the iliac crests, with the spine still flexed. A tracing of the moulded tape at each level is made on paper; this is cut out with scissors, pasted into the case-book, and a permanent record of the structural deformity obtained.

If the patient is seen years later, one can discover by taking a similar moulding whether the deformity has remained stationary or has increased. It is difficult to understand why this extremely simple method has not been generally utilised.

The deformity should not be recorded by observing how far the spinous processes have deviated from the middle line, as is sometimes attempted by drawings or photographs; for besides being exceedingly difficult to measure accurately, the amount of deviation is not a measure of the amount of structural lateral curvature. Often structural deformity is present in a severe degree, and yet the spinous processes are still practically in a straight line. The following passage from Mr. Tubby's "Deformities" will serve to emphasise this point: "In fact, we must judge of the presence or absence of curvature, not from the lines of the spines at all, but by rotation signs—*e.g.*, rib prominence backward on one side. And we may go further still, and add that if the rotation signs indicate, say, curvature to the right, whilst the line of the spines suggests curvature to the left, we must accept the evidence of rotation, and disregard the line of the spines."

If photographs are taken of the patient, they should be taken on the first day of examination; one set should be taken when the patient is in the "habitual position," and another when in the "best possible position" in which she can be put by the surgeon (Fig. 28). In the past a common practice has been to take the first set all right, but omit taking the second set until after a course of treatment. The great improvement demonstrable in this second set is then attributed to the treatment, whereas just as favourable a set of photographs could have been obtained before ever the treatment was begun.

(*b*) From the *side:* Observe the state of the normal antero-posterior curves; they are usually exaggerated.

The dorsal curve, with concavity forwards, is increased; the patient stoops, and pokes the head forwards, to bring back the centre of gravity to the middle of the body;

compensatory exaggeration of the lumbar lordosis develops, which makes the abdomen prominent.

Accompanying the stoop, there is a drooping downwards and forwards of the scapulæ.

FIG. 28.—"HABITUAL" AND "BEST POSSIBLE" POSTURES.
Patient with C scoliosis; all six photographs taken on the same day, before beginning treatment. (Bernard Roth.[1])

(*c*) From *in front:* Observe the degree of development of the chest, and the lung capacity, and look for a prominence of the ribs on one side or the other. When the right ribs are prominent behind, the left will be prominent

in front, and vice versa; this prominence causes the breast on that side to appear larger than the other, and the inequality so caused may be the first sign to draw attention to an otherwise unnoticed lateral curvature. Often the chest is badly developed, being flat or even hollowed.

Prognosis.—Having observed the "habitual" position in which the patient stands, it is necessary to ascertain the "best possible" position in which she can be placed (Fig. 28). This is not found by hanging her from a trapeze, or suspending her by the head, but by making her stand as erect as possible, with head straight, shoulders level and drawn back, chest out, abdomen in, and arms stretched down. (If one leg be short, a suitable block is placed beneath the foot.) She may only be able to maintain this position unaided for a few seconds, but if she can maintain it at all the parents may be assured that she can be trained to assume this position naturally, so that the "best possible" position will become the "habitual" one. One is therefore enabled on the very first day to demonstrate what improvement can be brought about.

When a case with even severe structural deformity is put in the "best possible" position, often much of the deformity is thereby hidden, and this is what the surgeon desires. *For once there is "structural deformity" it cannot be got rid of;* this must be explained carefully at the outset.

3. *The Clothes.*—After examining the patient, she is told to dress, and is placed in the "best possible" position as each garment is put on, the surgeon observing if it be sufficiently loose across the chest. In nearly every case the clothes across the chest will be found two or more inches too tight, inevitably preventing the assumption of the "best possible" position, even supposing the patient attempted it (Fig. 29). Very little improvement can be obtained in such cases if the clothes are not attended to first of all. As regards corsets, the patient should continue to wear those she is accustomed to, provided they can be made loose enough. If they are held in position by straps over

the shoulders, as in young girls, the stockings should be kept up by garters, and not by suspenders attached to the corset, for the continual pull of these is quite enough to make a delicate child stoop. Boys should wear a belt or **Y**-shaped braces which meet together behind high up, and so leave the scapulæ free.

4. *The Vision.*—This should be examined with test types: if anything abnormal is found, an oculist must be consulted.

5. *The Air-Passages.*—If there be nasal obstruction, an aurist should be called in to advise if any operative treatment be indicated. A free airway is essential for successful treatment.

Treatment.—This will depend on the views of the surgeon. The different methods at his disposal are:

1. Lying down for one or more hours daily.
2. So-called "gradual correction" in a support or corset.
3. So-called "rapid correction" in a plaster jacket.
4. Gymnastics.
5. Combinations of (1), (2), and (3) with each other and with (4).

Treatment of lateral curvature and stoop by lying down has only to be mentioned to be condemned; the idea of it is, of course, that as one of the chief factors concerned in the production of these deformities is weakness of the muscles, they will be able to manage all right if the amount of work they have to do is lessened. But this method does not take into account the fact that though the total work done in the day is less, the actual work done at any moment while the patient is up and about remains the same; and it entirely forgets that disuse leads to atrophy, the net result being that the muscles get still weaker, while having the same work to do when called upon to act. In practice, lying down makes the condition worse: the muscles become weaker, and the deformity increases. Where pain is present and is relieved by lying down, a vicious circle becomes established: the patient lies down to relieve the pain, and

in so doing further weakens the muscles; she then gets up and walks about, but the increased weakness causes the pain to come on sooner than before, and she has to lie down to relieve it, and so on.

"Gradual correction" in a support or jacket depends on the belief that it is possible to get rid of the structural deformity of lateral curvature by using force; but as this is utterly impossible, and no one has ever seen it happen, it seems ridiculous to apply such means. Moreover, the jacket or support has harmful effects: it prevents full respiration, and by partly fixing the spine causes the muscles which should move it to atrophy; when it is removed the spine is weaker than ever. Also, in spite of the jacket, the deformity goes on increasing. When I have pointed this out to doctors, they have said, "Yes, perhaps it does; but if we don't order supports someone else will; we must do something." And so patients are clapped into jackets, and no more trouble taken over them, while they slowly become hopelessly deformed.

"Rapid correction" has lately received much attention, having been reintroduced in a new form; but in spite of bold assertions, such as that lateral curvature "yields to treatment far more readily either than bow-legs or club-feet," or that "the parts entering into the deformity are actually turned back into their normal positions" (Abbot), I am more than ever convinced that the structural deformity of lateral curvature—*e.g.*, a rib prominence—once present, can never be got rid of. I believe that violent methods—and methods which have caused the death of patients (Lovett) must be considered violent—will temporarily cause a rib prominence to disappear, but I do not believe that these changes are permanent, or that the vertebræ themselves become changed at all.

"Gymnastic methods," which aim at increasing the patient's strength, are on an altogether different footing. They do not try to get rid of the structural deformity, knowing this to be impossible, and they do endeavour to cope with one of the chief causes of the condition, weak-

ness. Some of them, however, are of little value, because they think only of "undoing the curve," forgetting all about the patient's posture, which has helped to cause, and is still causing, the deformity, and because the exercises prescribed are too violent to be borne by weak and sensitive patients, and too complicated to be properly carried out. Some of the movements ordered are only included in the treatment because Ling thought they were good, or because a knowledge of them is demanded by a certain examining

FIG. 29.—TO ILLUSTRATE THE IMPORTANCE OF ATTENTION TO DRESS.

A boy, aged 14 years and 8 months. C scoliosis. A. "Habitual" position. B. "Best possible" position. C. "Best possible" position when dressed; the coat and waistcoat would not meet for 3 to 4 inches. Very little improvement could be obtained in such a patient if the clothes were not attended to first of all. All three photographs were taken on the same day, before treatment.

body. I have had experience of very many methods, and I am able to recommend one, and one only, that known as the method by *posture and exercise*, which is conducted on the following principles:

1. *Attention to Dress.*—If the clothes are not loose enough across the chest to allow of patients assuming the "best possible" position the efforts of the surgeon are largely wasted (Fig. 29). It often happens that patients are exercised undressed—a quite unnecessary proceeding—

and are then allowed to dress again in their badly fitting clothes, which at once cause them to assume the "habitual" position, the very position the surgeon wants to avoid. It is for this reason that no improvement in carriage is observed in patients after wearing spinal jackets; for they are fitted with the patient hanging from a trapeze or lying twisted on a sling, neither of which methods makes the patient assume the "best possible" position at all; and any effort on the part of the patient to assume a better position is prevented by the jacket. Often when such a patient is placed in the "best possible" position the sides of the jacket or support she has been wearing will not meet in front for three or four inches. Yet this is the appliance which it is confidently hoped will straighten up the patient.

2. *Daily Systematic Strengthening*, for from one to three months, of the spinal and other muscles, including development of the chest.

For a month the patient is made to do symmetrical exercises in the "best possible" position, regardless of the particular variety of curve present. After a month she is examined undressed again, and a position of the arms decided upon which makes the spine look straightest. This so-called "keynote position" may be—

Arms up, holding stick.
Elbows grasped above head.
Right arm up, left out.
Left arm up, right out.
Right arm up, left hand grasping right wrist.
Left arm up, right hand grasping left wrist.

Thereafter many of the exercises are done in that position. This has the effect in time of getting rid of a prominence of one hip, or of flattening out an exaggerated "arm space," both frequently the effect of bad posture. The exercises are done with the clothes on. After each exercise, the child places herself in the "best possible" position against the wall, and then walks to her seat and sits down, still with her spine in that position, and so remains until called

upon to perform the next exercise. The "best possible" position against the wall is one in which the heels, calves, buttocks, scapulæ, and occiput are all touching it, the head being held straight, the eyes looking horizontally to the front, the chin drawn in, the abdomen drawn back, the shoulders also drawn back, and the arms stretched down by the sides and rotated out so that the thumbs point outwards.

At first the exercises are very easy, but gradually they are made more and more difficult as the strength of the patient increases. They consist largely of concentric and eccentric movements, patient resisting or surgeon resisting, and of simple ones carried out under the supervision of an assistant. As the patient progresses, some of the resistance exercises are deputed to the assistant; but the surgeon is always present to conduct and control the treatment. In each case the surgeon has to feel his way and gradually increase the work done by the patient. Some have to be treated with the utmost care for several weeks before they can tolerate the slightest increase of effort; and the setting up or aggravation of spinal pain by injudicious movements may delay the cure repeatedly.

The exercises must be done daily: this is the only way to overcome the effects of habit, and to strengthen the weak muscles quickly. Exercises twice a week, a favourite prescription, are almost useless. The apparatus required consists of a low, padded, adjustable, horizontal bar (Fig. 30, A, Frontispiece), a high plinth (Fig. 30, B, C, D), a couple of high couches or massage tables, and a vertical ladder (Fig. 31, G), besides couches and seats for the patients to rest on in between the exercises.

In a typical case, about the third week, the following exercises will be gone through:

1. Lying, deep breathing, in through the nose, out through the mouth; first with the arms down by the sides, then with the arms stretched up by the sides of the head.

2. Lying, leg circling, with weights—*e.g.*, one pound—applied to the feet to act as resistance. As the muscles gain in power the weights are increased.
3. Standing, thighs opposite bar, trunk flexion, patient resisting; trunk extension, surgeon resisting (Fig. 30, A); also pelvis fixed, trunk twisting, surgeon resisting.
4. Lying, arms circling, with weights in hands.
5. Sitting astride, trunk flexion, etc., as in (3) (Fig. 30, B, C).
6. Lying, arm extension, patient resisting; arm flexion, assistant resisting (Fig. 30, D). Also head flexion, patient resisting; head extension, assistant resisting (Fig. 31, E).
7. Forwards lying, feet fixed, trunk flexion, etc., as in (3) (Fig. 31, F); also swimming.
8. Standing back to ladder, trunk hyperextension, patient resisting; trunk extension, assistant resisting (Fig. 31, G); also pelvis twisting, assistant resisting; also hanging, knees up, trunk twisting, assistant resisting.
9. Forwards lying, leg circling, with weights.
10. Long sitting, trunk extension, surgeon resisting (Fig. 31, H); also trunk twisting, surgeon resisting.

During the execution of these exercises, to prevent interference with respiration by involuntary fixation of the chest-walls, and consequent heart strain, the patient should always count aloud from one to five or ten, which has the effect of forcing her to breathe regularly. This also regulates evenly the muscular effort. The patients are not treated separately, as a rule, but several together at the same time. While one is doing an exercise with the surgeon, another does one with the assistant, the others resting on chairs and couches, waiting their turn. Working on this plan, with two assistants, one can treat efficiently twenty patients in an hour and a half. An advantage in treating patients

together, apart from the saving of time, is that each profits from another's example, the advanced ones unconsciously assisting the beginners.

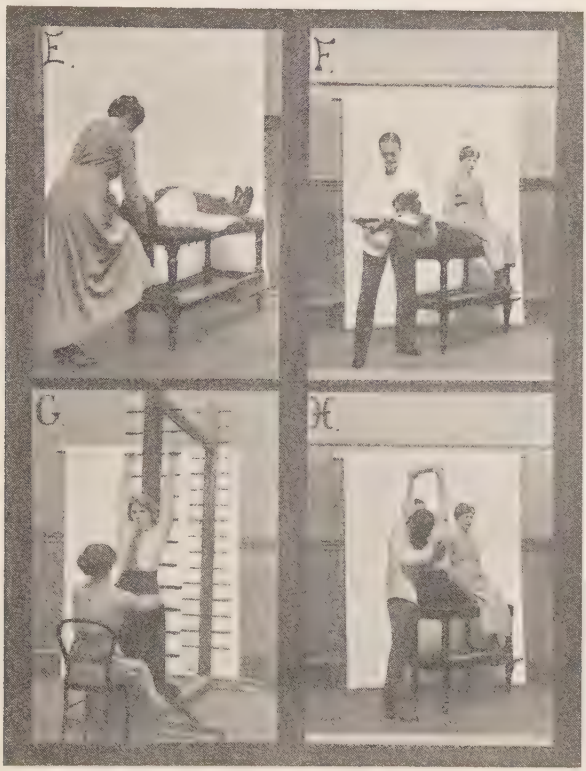


FIG. 31.—RESISTANCE EXERCISES FOR STRENGTHENING THE SPINAL MUSCLES.

E. Lying: head flexion, patient resisting; head extension, assistant resisting.
F. Forwards lying: trunk flexion, etc., as in A.
G. Standing back to ladder: trunk hyperextension, patient resisting; trunk extension, assistant resisting.
H. Long sitting: trunk extension, surgeon resisting.

3. *Daily Re-education of the Patient's Muscular Sense as to an Erect or Improved Position.*—A great many crooked patients suffering from lateral curvature, stoop, or round shoulders, when told to stand up straight, place themselves in a worse position than before (Fig. 32). Their muscular

sense of what is straight has become so perverted that the vicious posture appears to them quite natural, while the improved position in which they are put by the surgeon makes them feel as if they were crooked. Their muscular sense, therefore, must be re-educated. This re-education is carried out coincidentally with the strengthening of the muscles; while the patient is performing an exercise, she is made to assume the "best possible" position, and in the intervals between the exercises while she walks back to her

FIG. 32.—TO ILLUSTRATE THE IMPORTANCE OF RE-EDUCATING THE PATIENT'S MUSCULAR SENSE.

A patient, aged 19 years, with C scoliosis. A. "Habitual position." B. Position assumed by the patient when told to stand up straight.

place and sits down she is encouraged to maintain it. After a time this position becomes habitual, and the strengthened muscles enable her to maintain it all the time.

4. *The Improved Position to be Maintained all Day.*—It is not at all sufficient to give the patient treatment each day for an hour, and then let her return home to sit and stand and walk in the same old bad position until the next visit for treatment on the following day. Measures must

be adopted to ensure as far as possible that correct postures are assumed in the hours between each hour of treatment. Besides precaution as to position in writing, the patient should not stand at lessons, should always have a comfortable back to lean against when sitting, and should never be allowed to remain in a bad position if it can be helped. The parents have got to help in this matter, and continually keep an eye on the patient, at least for the

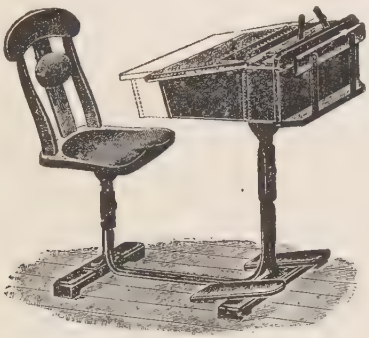


Fig. 33.—Hygienic Adjustable Single Desk (Hammer and Co.).

Special Features.

1. Designed to compel child unconsciously to assume a healthy posture.
2. Desk, seat, and back-pad readily adjusted to any fraction of an inch, so as to suit *each* child using them.
3. Sloping top placed at proper angle and distance from eyes ensures comfort in working without eye-strain.
4. Central pillar prevents practice of crossing the legs.
5. Adjustments, which are worked separately, are simple and efficient, and, being fixed with a set spanner by the teacher, cannot be tampered with.
6. Desk arranged to slide horizontally backward and forward to allow child room to get in and out, and yet prevent stooping when writing.
7. Seat shaped to fit the buttocks, and slightly tilted up in front, so that child is prevented from slipping off.

first few weeks. A proper "hygienic adjustable single desk" (Fig. 33) should be got for each child, carefully fitted to her size; when later she goes to school, she must do all her lessons in such a desk. One of the ways in which the surgeon's influence is kept up at home is by requiring the patient to place herself against the door for a few seconds in the "best possible" position before and after every meal; a mark-book is kept in which she records by a stroke

that she remembered to do this by herself, or by a nought that she had to be reminded. This is known as "meal-standing."

5. *Subsequent Home Treatment*, to prevent relapse from the improvement or cure that has been obtained by the surgeon.

To continue to enlist the patient's interest and co-operation in her case, she is given a "home prescription" of exercises to be done for half an hour every morning for six months. She is then examined again, and if there be no relapse, a shortened home prescription is done for twenty minutes daily for another year. In all cases it is essential to persevere in the maintenance of good positions until growth has ceased.

6. *Attention to General Health.*—Patients are encouraged to take outdoor exercise, walking, cycling, basket-ball, tennis, riding (astride), etc.; to eat plenty of food, especially fat, meat, fruit, and vegetables (they are weighed every week to detect any loss of weight); and to have ten hours or more of sleep. Lessons should be given up while attending for the course of treatment.

Position while Asleep.—As the whole point of the treatment depends upon the voluntary muscular action of the patient, guided by the surgeon, no possible benefit can arise by interfering with the position of the patient during sleep. Some patients treated by forcible methods are made to lie at night on plaster-beds moulded to correspond with the contours of their deformity; they are extremely uncomfortable, but otherwise seem to do little harm.

Remarks on the Treatment.—This treatment entirely stops the progress of the structural deformity, gets rid of the postural deformity, and makes the patient in all but severe cases look perfectly straight. It abolishes pain, if this be present, and renders the patient a happy, useful member of society instead of a confirmed invalid.

By carrying it out conscientiously the practitioner can obtain excellent results, but he must give his personal attention to it daily. Too often in the past the work has

been handed over to a masseuse, who cannot possibly appreciate the many points involved; after many months the doctor has been unable to observe any improvement, and he has then applied a support or jacket, the gymnastic treatment being undeservedly blamed.

If the legs are unequal, the boot-heel of the short limb should be raised by a cork elevator or extra lift of leather sufficiently to bring the pelvis level.

High heels should not be worn by those with lateral curvature or stoop, as they increase the strain on the already overtaxed muscles.

Piano and Violin Playing.—The former may be allowed provided the child sits in a good position on a stool with a comfortable back, and with the feet supported. The latter must be stopped altogether for the time being—in many cases permanently, as resumption is very liable to bring about a relapse.

Writing.—The position assumed in writing is largely responsible for the production of lateral curvature, and it is of great importance that the child should write at a properly arranged desk. The height of the seat and desk must be adjustable; the desk must be sloped, the paper placed obliquely, upright writing taught, the feet supported, and the light arranged to fall on the paper from the left. In a school there must be a separate adjustable desk for each child (Fig. 33).

Differential Diagnosis of Lateral Curvature.—There is only one condition commonly mistaken for lateral curvature—viz., Pott's disease. In this, the earliest sign is rigidity; when this is found, a radiographic examination should be carried out (see Pott's disease). Later on, when the disease has progressed, a prominence, consisting of a spinous process, appears in the middle line, whereas in lateral curvature the prominence consists of the ribs or erector spinæ, and is always situated to one or other side of the mid-line. Finally, if pain be present, in Pott's disease movement aggravates it, while in lateral curvature movement relieves it.

2. Flat-Foot ("Static Foot Trouble.")

The cause of this common condition is inability of the structures of the leg and foot to bear the strain which is put upon them. Not only the muscles are at fault, but also the ligaments and bones: they cannot bear the strain, and they give way. As to why they cannot bear the strain, there may be many reasons—weakness in infancy, overgrowth, illness, too much standing, etc., aggravated in many cases by badly-shaped boots and shoes and by faulty postures. Though commonest during the years of growth, it may occur at any age.

It has hitherto been the custom to describe various grades of flat-foot, with a different treatment for each; thus, bathing with sea salt or massage for slight cases; valgus pads and wedges and heels prolonged forwards for the moderate ones; irons and T-straps and frequent wrenchings for the severe cases; and extensive surgical operations for the very worst cases of all. With the exception of wedges, applied to the boots in a special manner, the whole of these treatments may well be discarded, one form of treatment, with but slight modification, being suitable for all cases.

In common with many other acquired deformities, the first change is a postural one; when the patient raises his heels from the ground, so as to stand on his toes, the arch is restored. It is only after the postural change has existed a considerable time that structural change occurs. Thus the cases can at once be divided into two classes: those in which the deformity entirely disappears when the patient stands with his heels raised, and those in which some or all of the deformity persists. For convenience, these may be described respectively as "postural" and "structural" cases, though it must be understood that in the "structural" ones much of the deformity may be "postural." In this connection mention must be made of those unusual cases where there is a painful spasm of the peronei muscles, producing a condition known as "spasmodic flat-foot."

The foot is held fully everted; any attempt on the part of the surgeon to forcibly untwist it only increases the spasm, and causes great pain to the patient. After a week's absolute rest in bed in a night-shoe the spasm entirely disappears, especially if treated by gentle stroking, and the foot turns back into the normal position; such cases must therefore be included in the postural class. Flat-foot complicated by this spasm has by some been regarded as a stage through which all cases must inevitably pass as they progress from bad to worse; but this is not so, the spasm only occurring most exceptionally. It must be considered an unusual complication.

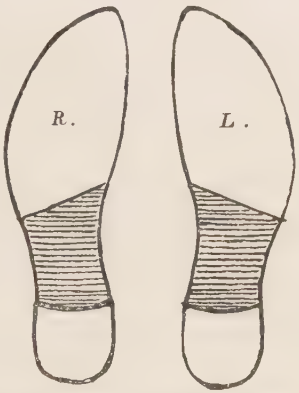


FIG. 34A.—THE SOLES AND HEELS OF A PROPERLY-SHAPED PAIR OF SHOES.

The following outline of treatment may be pursued with absolute confidence:

Object of the Treatment.—In the "postural" cases, to produce complete cure. In the "structural" cases, to abolish all pain and discomfort, to cure the "postural" element of the deformity, if present, and to arrest further increase in the "structural" element.

The treatment consists of: (1) attention to footwear; (2) attention to position in standing and walking; (3) regular daily exercise.

1. *Attention to Footwear.*—Whether boots or shoes are worn, whether they button or lace, they must be the shape of the feet (Fig. 34A). If this primary essential is not secured, the whole treatment may as well be abandoned To bring this about it is not at all necessary to wear boots of an ugly shape. The inner side of the boot, where the big toe lies, is kept straight, so that the end of the boot is opposite the big toe, and not opposite the second or third toe. This is to ensure that the big toe is not pushed out against the other toes, and has plenty of room in which to

act. The soles should be a fourth of an inch thick, the heels broad, and an inch in height. If the degree of flat-foot be anything more than the merest trace, mechanical means are used to throw the weight of the body, distributed down the leg, slightly outside the centre of the ankle-joint. This is effected by thickening the sole and heel of each boot along its inner side by $\frac{1}{4}$, $\frac{1}{3}$, or $\frac{1}{2}$ inch, the amount depending upon the severity of the case—the worse the case, the greater the thickening. The additional leather is in the form of a wedge (Fig. 34B), with its base to the inside and its apex to the outside of the foot, so that the extra thickness on the inside fades off to nothing on the outside.

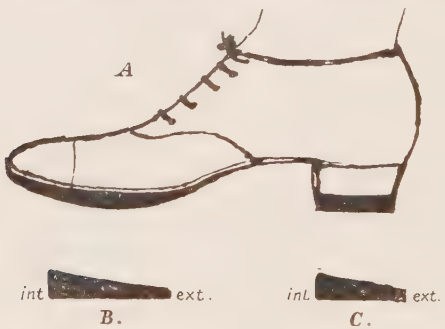


FIG. 34B.—A SHOE FOR THE RIGHT FOOT, SHOWING THE WEDGING OF THE SOLE AND HEEL.

Not only does it fade away outwards towards the outside, but also forwards towards the tip of the shoe, from a point situated 1 inch behind the tip. When viewed from in front, the wedge should scarcely be seen. The extra thickening is applied by a bootmaker to a boot of the shape described; there is no need to have a surgical boot made, and no need to have the instep filled in by a continuation forwards of the heel. The wedge is not plastered on to the sole—if it were, it would very quickly wear down—but the layers forming the sole are split open, from the inner side, and the wedge inserted between them.

2. *Attention to Position in Standing and Walking.—Standing:* The patient must always stand on both feet,

with the toes turned slightly in and the heels slightly turned out. He must never stand with the toes turned out, or on one foot to rest the other. Every now and then he must raise the heels just clear of the ground—that is, stand on the toes sufficiently to bring all the muscles of the foot into action. Whenever the feet begin to ache he should do this. In addition, he should stand with the feet very slightly turned over on their outer border. *Walking:* He must walk with the feet pointing straight forwards—never with the feet turned out. If the feet are hurting, he must walk all the time very slightly on tiptoe—that is, with the heels just off the ground. It is a good plan while indoors to walk on tiptoe all the time.

Fig. 35A.—Exercise for Flat-Foot. Standing, alternately Heels raising and Toes raising.

3. *Regular Daily Exercises.*—The exercises, to be done three times a day, preferably with the shoes off, are two in number: (1) *Standing, alternately heels raising and toes raising* (Fig. 35A). To steady the body both hands touch the back of a chair. The heels are slowly raised from the ground, and slowly lowered; then the toes are slowly raised and slowly lowered—the exercise thus consisting of four distinct movements. The feet are kept slightly turned in and slightly turned over on their outer border all the time. The exercise is repeated fifty times. (2) *Sitting* on one chair with the foot projecting over the edge of another, the calf of the leg resting on the seat. Keeping the knee still, the foot is slowly *circumducted* to its full extent in all directions, down, in, up, out, twenty-five times; then down, out, up, in, twenty-five times (Fig. 35B). If possible, the circumduction is done with the foot in a

slightly varus position the whole time. This is repeated with the other foot.

These directions must be followed uninterruptedly, and the exercises carried out daily, for at least three months, and as long after that as any disability is felt in the feet. In most cases the wedges give relief at once, and after three months exercises cease to be necessary, but the directions as to footwear and position must be adhered to for years. The wedges may, as a rule, be omitted after a year. In

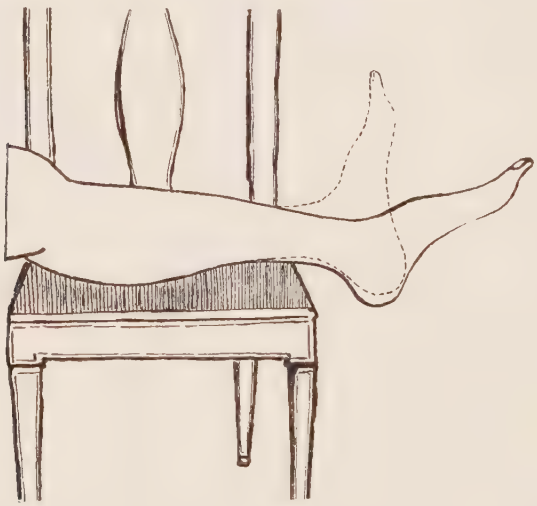


FIG. 353.—EXERCISE FOR FLAT-FOOT: SITTING, FOOT CIRCUMDUCTION.

addition, the patient should take to bicycling, care being taken that only the toes rest on the pedals.

Remarks.—This treatment removes the pain and discomfort of flat-foot. As regards deformity, it cures the slight cases, improves the moderate, and prevents the severe ones from getting worse. Even stiff and apparently hopelessly deformed feet get much more supple after a few months of this régime. The good that may be done by irons and T-straps, etc., is more effectively done by using the wedged soles, and the latter have the advantage of

cheapness and unobtrusiveness. There is one exception to this—where, as well as flat-foot, there is a marked valgus deformity: here a vertical concealed spring (Little's) incorporated in the outer side of the boot (Fig. 36), and to which the rest of the boot is laced up tight, materially helps to pull the foot over. Forcible wrenching under anæsthetics, either single or repeated, does not result in any permanent improvement to the patient. A few cracks are heard as adhesions give way, and the feet become more supple for the time being, but a week later they are

FIG. 36A.—LITTLE'S VERTICAL CONCEALED SPRING FOR THE TREATMENT OF VALGUS DEFORMITY OF THE ANKLE.

FIG. 36B.—THE SAME SPRING INCORPORATED IN THE SIDE OF A BOOT FOR THE RIGHT FOOT.

as bad as ever. Valgus pads, or arch springs, or sole plates should not be used. In some cases, it is true, they relieve the patient's symptoms; in many, however, they do not relieve at all, and frequently are so painful that the patients cannot wear them. Where they do relieve, they do so by forcing the patient to walk on the outsides of his feet, which is done just as efficiently and much more cheaply by the wedged soles. When they do not hurt, their great disadvantage is that they rob the foot of all its elasticity; the patient walks with a clumping gait. Larger boots than

usual have, as a rule, to be worn with them, and they have to be worn for years, during which time no active attempt is being made to improve the patient; they are at best palliative, not curative. Of late years they have been largely advertised by certain firms, and recommended for every form of foot trouble, regardless of its nature. I hardly ever examine a patient with painful feet who has not at one time or another tried arch supports; the amount of money wasted on them must be enormous.

Operative interference is not recommended; removing a wedge of bone from the inner side of the arch will improve the form of the foot, but not its function.

The spasmodic cases should be treated by absolute rest in bed in a right-angled tin night-shoe for a week. On removing the splint the foot will be quite straight, all spasm having gone. Soothing massage and gentle exercises should then be carried out for another week, the patient remaining in bed, but without the splint. In the third week the patient is allowed up, in properly-shaped shoes with wedged soles, and is encouraged to do a little walking, the exercises already described being gradually introduced until the patient is able to do the full amount of each. In a month a cure is obtained; but the patient must take care for several months not to walk too far or stand too long, while daily keeping up the prescribed exercises and directions as to posture. This treatment is perfectly successful, yet there are some who actually recommend an open operation and the excision of 2 inches of the peronei tendons.

3. Coxa Vara.

The normal "angle of inclination," the angle formed by the neck of the femur with its shaft, is about 125 degrees. When the angle of inclination is so diminished as to cause symptoms, the condition is known as Coxa Vara. In most cases that come for treatment, the angle varies between 90 and 45 degrees.

Coxa vara has been described as due to a variety of

causes, the chief being so-called "late rickets" and trauma. Too rapid growth is the only cause which seems to account for many of the cases, which occur in "overgrown" boys of fourteen or fifteen. Though commonest between the ages of thirteen and seventeen, it also occurs occasionally in small children: I have seen one case in a child of three

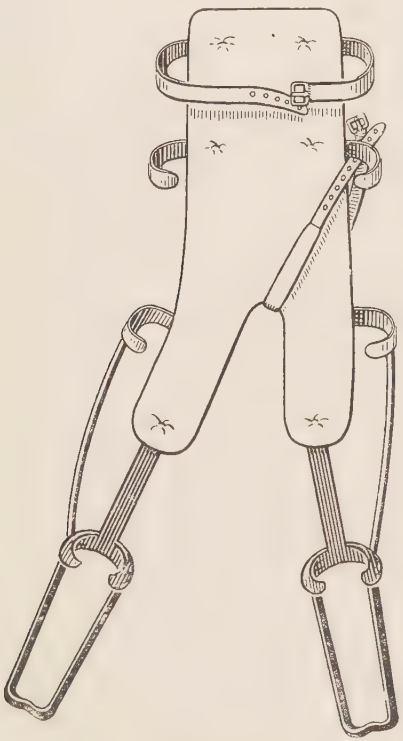


Fig. 37.—Abduction Frame for Right Coxa Vara.

and a half. The neck of the bone may (1) gradually bend, giving rise to pain, limp, wasting of muscles, and limitation of movement, which symptoms at first sight strongly suggest hip disease; or (2) a sudden partial separation, or fracture, in the region of the upper epiphysis may take place as the result of slight trauma.

The signs of the trouble are: shortening of the limb;

raising of the great trochanter above Nélaton's line; limitation of abduction (from the great trochanter locking against the innominate bone); and diminution of the angle, as shown in the radiogram. Sometimes the epiphysis may be entirely separated off (Fig. 39).

The trouble may occur on one or both sides. It appears to be much commoner in boys than girls. When bilateral and severe, the two lower limbs cross each other at the knees, producing the deformity of "scissor-legs," and rendering walking impossible.

Treatment of an early case should be carried out recumbent in an abduction frame (Fig. 37). Later on a Thomas's hip-splint may be applied if the condition be unilateral, and the patient allowed to get about with a patten on the sound foot.

Inveterate cases, where the legs are crossed, must be treated by "subtrochanteric osteotomy," an osteotomy of the shaft done immediately below the lesser trochanter. The osteotomy is carried out in exactly the same way as in genu valgum, the osteotome being introduced on the outer side. After the osteotomy, the limbs are forced straight—the adductors being divided subcutaneously if necessary—and placed in plaster of Paris or a double Thomas's hip-splint, which is retained for from two to three months. If plaster be used, it must include the pelvis, knee, and foot; but the Thomas's splint is preferable, as it allows of daily massage to the whole limb.

[1] "Treatment of Lateral Curvature of Spine," 1899.

CHAPTER VII

FRACTURES

1. General Remarks.

When a bone is fractured, the aim of treatment should be to produce a perfect functional result. To bring this about, it is necessary that the fragments should lie in accurate apposition. This is not always possible; but where it is possible, the surgeon is bound to make use of the method of treatment necessary. When I was a house-surgeon in a large hospital, the treatment of a fractured femur consisted of encasing the patient in a plaster splint and packing him off to the infirmary. The quicker one got him out of the hospital the more pleased was everyone concerned. The treatment of a Pott's fracture was carried out on exactly similar lines: a plaster splint was applied, and the patient pushed out. The results of this treatment were deplorable. When the plasters were removed months later, wasted, deformed limbs were discovered, with which the patients never walked normally again. I wish I could think that these methods were being given up—but I know they are not. The need for a common-sense humane treatment is as necessary now as ever it was. Let me outline what really should be done.

A good radiogram must be taken of the fractured bones—both an antero-posterior and a lateral view. If *both of these show the fragments accurately opposed to each other, with correct alignment*, the parts should be kept in the same position as when the radiograms were taken until bony union is complete. If splints are necessary to keep them in this position, splints must be applied; but they

must be easily removable, and the less splinting the better. If splints are applied, radiograms in two planes must be taken again, to ensure that the position of the fragments has not altered. If *either of these show the fragments not accurately opposed, or not in good alignment,* an anæsthetic should be given, and the fragments gently manipulated into the best position possible, retaining them there with suitable splints or means of fixation; radiograms taken the same or following day will show whether the desired improvement has been obtained. If it has not been obtained, and if there is small likelihood of obtaining it by further manipulation, an open operation must be decided upon if this is likely to improve matters. At the operation a long incision will be made over the site of the fracture, and the ends of the bones laid bare and accurately fitted to each other. If they remain in good position without tendency to displacement, the wound is closed, and treatment proceeds as before. But if there be any difficulty in keeping the bones together in position, they are fixed there by some means, such as a steel plate and screws, or a silver wire, or a bone inlay, etc., whichever is most convenient, after which the wound is closed and a suitable splint applied.

Having got the case with the bones in good position, the next step in the treatment is the employment of massage and movements. This should be carried out by the method introduced by Lucas-Championnière under the name of "*mobilisation and massage.*" Every day for twenty minutes morning and evening the damaged limb should be stroked longitudinally very gently and caressingly from the periphery to the centre at a uniform rate of fifteen strokes to the minute, and the joints above and below the fracture put passively but very gently once or twice through their range of movement. The stroking should be done very gently and regularly, as if one were stroking a cat, allowing the hand to mould itself to the contours it passes over; the hand should only just touch the surface of the skin, almost as if one were making mesmeric passes over it.

This stroking sends up soothing messages to the brain, which in turn sends out soothing messages to the damaged part so urgently in need of them. As a result, muscular spasm relaxes, pain is lessened, congestion is relieved, and repair is hastened. The stroking does not act mechanically, but neurologically. To the masseuse trained to use the ordinary methods of massage—light stroking, firm stroking, friction, kneading, tapping, and vibrations—this delicate stroking method appears quite inadequate to produce any result, and she can with difficulty be persuaded that much of what she has been taught is quite unnecessary. Yet in the hands of Lucas-Championnière and his followers magnificent results have been obtained, far better than any that the ordinary methods of massage can produce. Pain and swelling disappear in an extraordinarily short time, and firm bony union takes place weeks, if not months, before it would hitherto have been customary to expect it. As an example of its employment I can cite the case of a middle-aged waiter at the Criterion Restaurant, who sustained a complete transverse simple fracture of the shaft of the tibia, and who, after being treated by this method, was back at the Criterion on his feet all day long without complaint five weeks after the date of the accident. The method is entirely painless—is, in fact, delightfully soothing—cannot displace the bones, and can be applied to the limb without taking it off its splint. Moreover, a nurse of the proper temperament can be taught how to carry out the method for the treatment of fractures in a few minutes, instead of having to go through a laborious course of many months.

When bony union is established, any splints or appliances that have been used are left off, and the patient encouraged to begin and use the limb, the daily strokings and movements of the joints above and below being persisted in until all pain and tenderness have gone.

Remarks.—There is no need to apply a splint simply because a bone is fractured; if the bones will remain in position without it, its application is a needless annoyance.

A great many fractured legs do very well if allowed to lie flat on the mattress, which is prevented from sagging by the introduction of a couple of transverse boards between it and the springs; especially is this true of fracture of the tibia without displacement. In the upper extremity, all cases of fracture of the humerus are best treated in the Thomas's sling, the chest wall acting as a most efficient and most comfortable splint, and none other is required.

In choosing splints, one should use only those which keep the parts in position, which are comfortable to the patient, and which allow the site of fracture to be inspected without removing them.

In operating, the technique employed must be that of Arbuthnot Lane—the skin hidden by towels clipped on to the edges of the incision, the fingers never once introduced into the wound, only the "non-business end" of the instruments ever touched with the hands, all bleeding arrested by forcipressure without the use of ligatures, and the skin closed with Michel's clips.

The means commonly employed for fixing the bones together are: (1) silver wire; (2) Lane's steel plates and screws; (3) various patterns of clips similar to those which clip a pump on to the frame of a bicycle; and (4) bone "inlays." All these are intended to remain in permanently.

1. *Silver wire* is useful for small fragments where there is not room for a plate—*e.g.*, in fractures of olecranon and patella—and in comminuted fractures of long bones, to hold the various pieces together as a piece of string is tied round a bundle of firewood.

2. *Lane's plates and screws* are specially applicable in transverse fractures of the long bones with much displacement. Here there is much leverage exerted by the limb, tending to displace the fragments, and a good grip of the bone by something that will not break nor let go its hold is required. Care must be taken to apply the plate in such a position that it is covered by muscle; if it lie subcutaneously it is almost certain to irritate the skin, and so eventually require removal.

3. *Clips* are useful where the line of fracture is very oblique, each clip being able to grasp two fragments; they have the advantage of not requiring any hole to be drilled into the medullary cavity, being applied to the bones with the minimum of disturbance; but they do not grip as well as a plate and screws, and they are no good when the fracture is transverse.

4. *Bone "inlays"* are all the fashion. An inlay consists of a rod of bone shaped like a stick of sealing-wax, cut with a motor-driven double circular saw from the patient's tibia or from one of the fractured fragments. After the fragments have been accurately adjusted, a gutter is cut in them as they lie in apposition with the same double circular saw, and the inlay placed in it and secured there with kangaroo tendon stitches passed over it and through holes drilled in the sides of the gutter.

It is claimed that these inlays become completely incorporated in the new bone, and are not foreign bodies in any sense of the term. They do not give rise to any irritation, and never have to be removed. Their disadvantage is that they are brittle and can stand little strain; they are not nearly so easy to cut and fix as is represented in the advertisement of the special outfit of instruments required; and it is not every patient who is willing to have an additional operation performed on one of his legs to cure, say, a break in the other. On several occasions, a fracture has occurred later in the bone from which the inlay has been taken.

2. Treatment of Certain Fractures of Orthopædic Interest.

Clavicle.—Put the patient to bed, without a pillow, and keep him there on his back for two weeks, using no splint or bandage. The deformity produced by gravity and muscular spasm disappears, and a perfect result is obtained. Exceptionally, in very bad cases an open operation is necessary. The well-known Sayres's method with strapping does not reduce the deformity, and may cause paralysis of the hand. If the patient refuses to

go to bed, the condition is best treated by placing the limb in a simple sling under the clothes for two or three weeks, but there will be some resulting deformity. In small children, the sling is all that is necessary.

A complication of this injury is traumatic synovitis of the shoulder-joint (see p. 67), and the symptoms of it may persist long after the fracture is healed, and cause much trouble if not recognised and appropriately treated.

Humerus.—Whatever other treatment may be adopted as well, all fractures of the humerus are to be treated in Thomas's sling, the wrist being tied to the neck with the elbow flexed at an angle of 45 degrees. The patient must not lie down for a week or ten days, and when in bed must be propped up with pillows, so that the elbow can hang down and act as a constantly extending force.

A radiogram must be taken with the sling applied; if it show the bones in good position, no other treatment is required. If it show them not in good position, manipulation under an anæsthetic, or open operation, will be necessary. In some cases good alignment will be obtained by abducting the arm; this is done by fixing a suitable cushion between the elbow and the side. In fracture dislocations of the upper end, an open operation must be done within a few days, and the bones replaced in good position; if this be not possible, the upper fragment, consisting of the head, should be excised. In fractures of the shaft it is unwise to allow overlapping to remain unreduced, for fear of the musculo-spiral nerve becoming involved in callus—manipulation, or, if this fails, open operation are called for.

Fractures of the lower end are very common in childhood; they are described as separations of the lower epiphysis, but careful radiograms generally show a fracture has taken place just above the epiphyseal line. There is often much displacement of the lower fragment—carrying with it the radius and ulna—laterally or antero-posteriorly, and much crippling of the limb will result if the displacement be not reduced. Fortunately, manipulation is usually quite successful.

In all these fractures the Thomas's sling may be safely removed when the patient is able voluntarily and painlessly to place his hand on the top of his head.

Ulna.—The olecranon process is frequently fractured off, either by violent muscular action of the triceps, or by a fall on the elbow, the humerus cutting off the olecranon as a hatchet chops the end off a piece of wood. At the moment of fracture it may be separated some distance from the rest of the ulna, but if the elbow be extended the fragments approximate, and it would appear that by keeping it extended a good cure could be brought about. But fibrous union is very liable to follow such treatment, and the fibrous union may gradually stretch and cause very considerable loss of power in the limb. In deciding, then, upon the course to follow, the occupation of the patient must be taken into account: where hard physical work has to be done, open operation and wiring together of the fragments is essential; but in those who lead a sedentary or gentle life, and who do not play active games like golf or tennis, wiring is an unnecessary procedure, and treatment by keeping the bones approximated in the extended position for a week or ten days is eminently satisfactory.

Where the fracture is compound and becomes infected the limb should be treated in the Thomas's sling with the elbow flexed at 45 degrees, for if ankylosis occur in the joint this is the most useful position for a stiff elbow, ankylosis of the elbow in the extended position rendering the limb almost useless.

Radius.—The chief fracture of interest is the obliquely transverse one of the lower end, known as Colles's, produced by falls on the outstretched hand. In a typical case the lower fragment is impacted against the upper, and is displaced bodily backwards so as to form a prominence on the back of the wrist. The fragment is also rotated (1) on its transverse axis, so that its lower surface faces downwards and slightly backwards, instead of downwards and slightly forwards; and (2) on its antero-posterior axis, so that its styloid process is raised to the same level as the styloid

process of the ulna—normally it is half an inch lower than the latter.

Treatment.—If the lower fragment be allowed to stay in this bad position, complete normal mobility of the wrist will never be possible again. Fortunately, one is able by a simple manœuvre to replace the fragment in its proper position, and this should always be done.

Method.—After a radiogram has been taken and inspected, the patient is anæsthetised with chloroform and ether, and the fragments disimpacted. If the right radius is affected, the surgeon, standing on the right of the patient, grasps with his left hand the hand of the patient in such a manner that the palm of his hand is in contact with the back of the patient's hand; at the same time the surgeon's right hand grasps the lower third of the patient's forearm in such a manner that the palm of his hand is in contact with its anterior surface. Then, with his left hand, he forcibly *flexes* the wrist completely, which disimpacts the fragments, and forcibly *rotates the hand in* (pronates it), while with his right hand he simultaneously *rotates the forearm out* (supinates it), which has the effect of twisting the lower fragment on its axis back into position again. The hand now lies completely flexed, with the forearm fully pronated; and this position must be maintained for a week by means of a malleable iron splint 12 inches long by 2½ inches wide, bent to the right shape, and bandaged to the anterior or palmar aspect of the forearm, wrist, and hand, as far as the proximal interphalangeal joints, the second and third phalanges of the fingers and the whole of the thumb being left free to move. The limb is placed in a sling, with the hand projecting from it downwards. Each day the bandage is removed for the gentle stroking treatment, and the finger-joints and elbow-joint moved a few times. The patient is urged to move his thumb and fingers repeatedly during the day. Another radiogram is taken to confirm the maintenance of the good position of the fragments which has been obtained by the manipulation. After a week the splint is removed, and the patient instructed to begin to use the

hand, keeping it most of the day in the sling. In another week the sling may be dispensed with.

Remarks.—Unfortunately, these cases are often treated on straight anterior splints, or on a Carr's splint, without previous manipulation; or if they are manipulated, any benefit produced is negatived by not keeping the wrist fully flexed afterwards.

It sometimes happens that the limb does not get strong as quickly as is wished after the injury: the patient complains that when he holds his hand outstretched, the weight of the hand hurts him; this signifies that the wrist-joint has not recovered from the traumatic synovitis set up by the injury, and a further period of rest, this time on a straight anterior splint, for two or three weeks more is indicated.

Fractures of the Radius and Ulna.—A fracture of the shafts of both bones is often a very trying condition to treat successfully. (1) It must always be treated in the fully *supinated* position. The old rule of treating it in the supinated or pronated position according as the site of the fracture happened to be above or below the insertion of the pronator radii teres muscle is to be discarded entirely: it gives bad results. (2) If there be much displacement of the fragments, with likelihood of cross-union taking place between the radius and ulna, the fragments of one or both bones must be cut down upon, freed, brought into accurate apposition, and, if need be, kept there with a small plate or clip. The decision whether to operate or not must be made after a radiogram has been taken in the fully supinated position. If both bones are operated on, it is advisable to do both operations on the same day; if one is done one day, and the other two weeks later, the manipulation necessary to free the fragments of the second may disturb the position of those of the first. After the operation, the forearm should be kept fully supinated for three weeks in a leather gutter-splint—extending from just above the point of the elbow to the tips of the fingers—supported by straps round the patient's neck (Fig. 38).

Scaphoid Bone of Wrist.—This is often not diagnosed, being mistaken for sprained wrist or Colles's fracture. When diagnosed as the former, the surgeon does not think it necessary to have a radiogram; and in the latter case, when the radiogram is taken, the radius and ulna appearing normal, he may think there is no bony injury, unless he takes the trouble to count the carpal bones, when he will find there are nine instead of eight, the scaphoid having been split into two equal and regular halves. When detected, the condition must be treated, as pointed out by

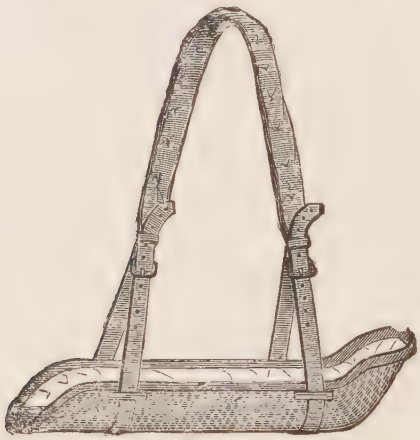


Fig. 38.

Jones, in the dorsiflexed position in a dorsiflexed wrist-splint (Fig. 25). If not so treated, the wrist may become permanently fixed in a dropped position—owing probably to excessive callus forming in the gap between the fragments—and the condition can then only be partly relieved by excision of the scaphoid, in itself a most difficult operation. If the fragments of the scaphoid be dislocated on to the dorsum of the wrist they should be promptly excised.

Femur.—*Fractures of the neck* are best treated in a single Thomas's hip-splint. If there is impaction of the fragments they should be left undisturbed, and extension should not be

applied. In old people the Thomas's splint may not be tolerated, and all that can be done is to keep them on a water-bed with the limb supported by pillows; but the ideal treatment is undoubtedly the splint, in which they can get about with crutches, swinging the leg and wearing a patten beneath the other foot. These old patients are very liable to develop hypostatic congestion of the lungs if kept in bed without moving, and if we can get them up so much the better.

Much more frequent than fracture of the neck in young

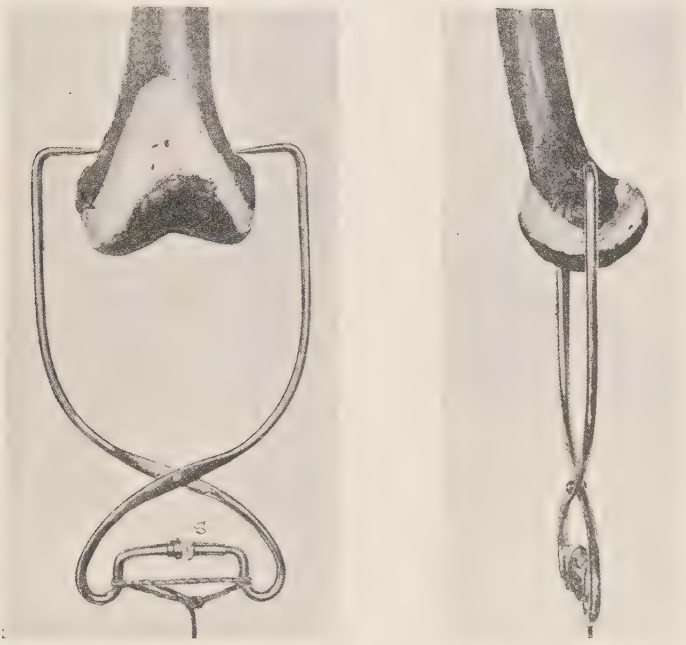
FIG. 39.—RADIOGRAMS SHOWING PARTIAL SEPARATION OF THE UPPER EPIPHYSIS OF RIGHT FEMUR CAUSING COXA VARA, AND COMPLETE SEPARATION OF UPPER EPIPHYSIS OF LEFT FEMUR, OCCURRING IN A GIRL AGED SIXTEEN YEARS.

subjects is *separation of the upper epiphysis* (Fig. 39). This may occur as the result of a trivial accident, or even no accident at all; thus, a boy turned over quickly in bed and felt something give way in his hip: radiographic examination showed a complete separation of the upper femoral epiphysis. This separation produces severe coxa vara unless treated for some months in an abduction frame. This consists of a modified double Thomas's hip-splint, in which the iron for the affected limb is inclined outwards at the hip in order

to allow it to be treated in the abducted position (Fig. 37). The patient must lie in this until consolidation of the fragments is complete, and will then be allowed up in a single Thomas's hip-splint, with patten and crutches. This will have to be worn for a year at least, or the neck will bend under the weight of the body.

Fractures of the Shaft.—Fractures of the great trochanter and of the shaft should all be treated in a Thomas's bed knee-splint with extension. (In small children, however, excellent results are obtained by slinging the limb vertically by the foot to a hook in the ceiling or a gallows fixed to the bedstead. The length of the sling is adjusted so that the child's buttock is just clear of the mattress.) After the Thomas's splint has been applied, a radiogram is taken to ascertain the position of the fragments. If there be overlapping, this is got rid of by further extension, and by the addition of lateral slings to pull the bones into line. Hitherto, when this has not been successful, an open operation has been done, and the fragments of the femur levered into position and kept there with a Lane's plate. Recent experiences, however, in the treatment of fractures of the femur by extension, notably in the femur wards of the South African and Canadian Military Hospitals, have shown that, provided a new method of extension be employed, open operation in recent cases is very seldom required. This method is as follows: Under an anæsthetic a Thomas's bed knee-splint is applied, and extension made on the lower fragment of the femur by using a modified form of ice-tongs (Major Pearson's), the teeth of which grip the shaft on either side just above the condyles without penetrating the bone (Fig. 40). By this means the knee and ankle joints are left free, and all chance of subsequent stiffness in them avoided. In order to allow of daily movements and massage of the knee and ankle, an additional lower half is added to the splint, as suggested first by Watkin Williams (Fig. 41), which hinges on to it opposite the knee-joint, and enables the leg to be flexed on the thigh without in any way interfering with the extension, which

is still exerted in the line of the thigh. To the additional lower half is added a foot-piece, to the top of which the foot is slung by a strip of bandage glued to the sole of the foot. Owing to the efficient action of the extension, a pull of from five to ten pounds is sufficient to abolish the over-



A B

FIG. 40.—ICE-TONGS APPLIED FOR TRACTION ON LOWER FRAGMENT OF FEMUR.

A. The white area on the bone is that covered by synovial membrane of knee-joint. The screw *S* is regulated, when a grip of the bone has been obtained, to prevent any penetration of the points. Note the attachment of the cord.

B. Lateral view of same.

To apply ice-tongs, an incision 1 inch long is made down to the bone on either side.

(From a photograph kindly given me by Major Pearson.)

riding; if lateral apposition is not perfect, it can be brought about by lateral slings attached to the side bars of the main splint. The whole treatment is controlled by radiograms taken with a portable outfit.

This treatment must be carried out on a special bed (Major Pearson's), and therefore removal to a hospital or nursing home is generally desirable. The bed is made by Messrs. Whitfield, Ltd., Birmingham.

I am in entire agreement with Major Pearson that the present-day treatment of fractured femur is a reproach

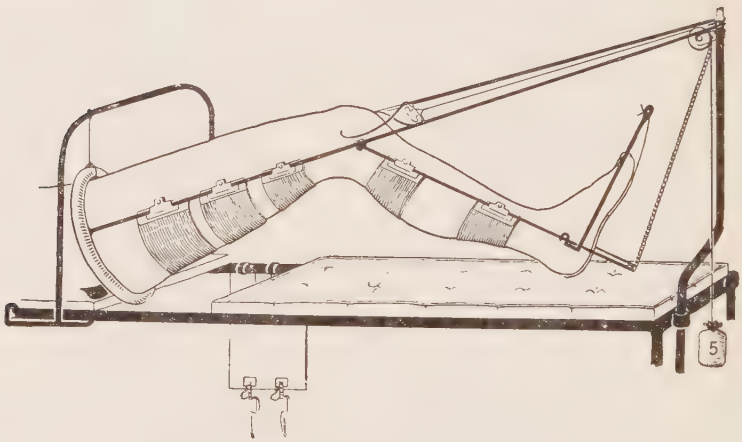


FIG. 41.—VIEW OF METHOD FOR TREATING FRACTURES OF THE FEMUR WITH ICE-TONGS, MODIFIED THOMAS'S SPLINT, AND SPECIAL BED.

The bed is made in sections, so as to be dropped down as in photograph, to allow of a radiogram being taken, or for dressing of wounds, etc., without moving patient at all. The under part of the ring of the Thomas's splint presses tight against the tuberosity of the ischium, marked in black. To keep upper part of ring from pressing on front of thigh it is suspended in the manner shown. Note the way in which the foot is kept from dropping: by a strip of bandage glued to the sole of the foot, and fixed to the top of the foot-piece with a knot, which is untied every day for massage and movements of the ankle. The Thomas's splint proper is fixed to the vertical bar at the foot of the bed; the end of the additional lower half is attached to a chain, which can be shortened or lengthened to vary the angle of flexion of the knee.

(From a photograph kindly given me by Major Pearson.)

to the surgeons; in every hospital wards should be set aside for the treatment of this and other serious fractures, under the care of a specialist surgeon really interested in them. Too long has their treatment been left to the overworked house-surgeon.

In old cases, with much displacement and overlapping,

and with, say, 3 or 4 inches of shortening, extension cannot reduce the deformity, and an open operation must be done. Here Lane's methods are invaluable. Through a long incision the fragments are laid bare with his "bone levers" and "spikes" and "periosteal detachers," and first the end of the upper and then the end of the lower fragment grasped in his long "bone-holding forceps," and drawn out of the wound of operation until both fragments lie almost parallel to each other, the thigh being practically bent in two. The two ends having been freshened, are then made to impinge one on the other, and, using these as a fulcrum, the two fragments are gradually straightened out by assistants moving the limb until they lie in perfect alignment, both having been moved through an arc little short of 90 degrees. A long steel plate is applied, and the wound closed. A bone inlay or clip is no good here; only a long plate with many screws has sufficient strength and grip to withstand the great tendency to displacement which exists for the first few days after the operation, due to the pull of the shortened muscles and fasciæ. When the shortening has been considerable, the soft parts have to be stretched perhaps 3 or 4 inches.

Even with a plate the screws may tear out of the bone, if the previous shortening has been marked, and a Thomas's bed knee-splint should be worn as an additional precaution.

As soon as the wound is soundly healed, say in three weeks' time, daily voluntary exercises should be started to get back the strength of the thigh muscles, and to assist bony union. The best is "leg circling" (p. 88); this should be preceded by massage. A radiogram is taken to verify the good position. When the patient first gets up, a Thomas's calliper walking knee-splint should be worn.

Fractured Patella.—This is usually caused by a violent muscular effort made by someone to prevent himself from falling; the patella cannot stand the sudden great strain, and snaps in two transversely, the upper fragment being pulled away from the lower one by the quadriceps muscle, leaving a gap between. Bits of torn ligament and fascia

lie in this gap, and prevent approximation of the fragments, so that bony union does not take place. The result, unless operation be done, is a very much weakened limb, sometimes with complete loss of the power to extend the leg on the thigh, for the fibrous union may stretch to a remarkable degree. I have under my care one such case where operation was not done, in which the fragments are separated by a gap 3 inches wide.

But an operation should be performed in every case. A vertical median incision is made down the front of the knee, and the two fragments cleared of all intervening tissue, and fixed together with silver wire, the wire being passed transversely through each fragment and twisted up tight on the outer side.

The operation should be done a week or ten days after the accident; this gives time for all bleeding to have ceased, and for the traumatic synovitis set up by the injury to resolve. It is, perhaps, needless to add that the operation must only be carried out in a proper theatre by an experienced surgeon.

After the operation the limb should lie on a pillow placed lengthways beneath it, with the mattress supported by fracture-boards. The patient is made to move the knee a little bit more each day until after three weeks he can flex it to a right angle. He may then be allowed up in a Thomas's calliper walking knee-splint, which should be worn during the day until the radiogram shows bony union of the fragments.

During convalescence great care must be taken that the patient does not have a fall, or he may break the wire and burst the knee right open, skin and all, and infect the joint.

Shaft of the Tibia.—When there is little or no displacement fractures of the shaft do very well with the leg between sandbags on a flat mattress which has fracture-boards placed beneath it. The patient lies turned on the affected side with the knee bent so as to relax the tendo Achillis. If this position be not comfortable, it may often be made so by placing the limb on a short back splint with foot-piece and external angular splint added (Fig. 42). Another

comfortable method is to place the limb on a short back-splint with foot-piece, add two straight lateral splints, and swing the whole in a fracture cradle (Lawrence's), allowing the patient to lie on his back with his knee bent (Fig. 43). Each day the limb must be massaged gently, and the patient made to move the knee and ankle joints. Except during massage, the knee should be kept flexed the whole time at 120 degrees, with the foot at right angles to the leg. When the radiogram shows there is displacement of the fragments, with overlapping and shortening, the proper treatment is to cut down on the bones, clear the ends, raise them out of

FIG. 42.—SHORT BACK-SPLINT, WITH FOOT-PIECE AND EXTERNAL ANGULAR SPLINT ADDED, FOR FRACTURES OF THE TIBIA.

The external angular splint is hinged to the main splint, and can be flapped back to facilitate padding; it is purposely made shorter than the back splint so as not to press on the head of the fibula.

the wound, and let them drop back into perfect position, fixing them if necessary with a plate, or clip, or inlay. If a plate is used, it should be applied on the antero-external surface of the tibia, so that it will lie covered by muscles; if applied to the antero-internal surface, it is almost certain to irritate the overlying skin, and so require removing later.

Shaft of the Fibula.—Fractures of this require no treatment beyond rest in bed and massage.

Shafts of the Tibia and Fibula.—Fractures of these are treated as for fracture of the tibia alone. In no case is it necessary to operate on the fibula; overlapping of its

fragments appears to be of little importance; and its middle third may even be cut out and used as a bone graft elsewhere without causing any permanent inconvenience.

"Pott's Fracture." — This is the name given to all fracture dislocations of the ankle, except the rare cases where, in addition to other injuries, the inferior tibio-fibular ligaments are ruptured, and the tibia and fibula in consequence forced apart by the rising up of the astragalus between them. These rare cases are known by the name of "Dupuytren's fracture."

A Pott's fracture may be produced either by forced abduction of the foot, or by forced adduction, as in stumbling on the curb in the dark or twisting one's foot on a loose stone. In a typical abduction case there is a snapping off of the

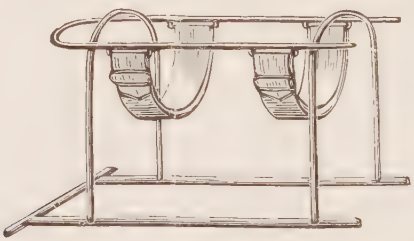


Fig. 43.

internal malleolus accompanied by a spiral fracture of the shaft of the fibula just above the external malleolus. The fractured-off internal malleolus is carried outwards, pushing the astragalus and foot with it, and often jams beneath the tibia, preventing reduction.

Treatment consists in adducting the foot under an anæsthetic, and laying the limb on its outer side in the splint already described. If the radiogram now taken shows the fragments of the tibia in good position, well and good; but if there still be displacement, and there be little chance of further reducing it, the internal malleolus should be cut down upon, freed, brought up into position by inverting the foot, and fixed there with a small Lane's plate. This plate is applied to the posterior border of the malleolus, so as not to lie immediately beneath the skin.

In an adduction case the external malleolus is snapped off and displaced inwards, carrying the astragalus and foot with it. In addition there is an accompanying fracture of the internal malleolus or a vertical fracture of the lower end of the tibia into the joint. Treatment is just the reverse of that used in an abduction fracture: the foot is abducted and a radiogram taken; if the deformity has not been successfully reduced, the external malleolus is cut down on, freed, brought up into position by abducting (everting) the foot, and fixed there as before with a plate. It is not necessary to operate on the tibia.

Lane has formulated a rule to cover all these cases: operate on and replace the malleolus which has been displaced towards the centre of the foot. In adduction fractures this is the external, in abduction fractures the internal malleolus.

If the bones are left displaced, a deformed foot results, which is quite unable to bear properly the weight of the body. Especially is this the case in abduction fractures. After these latter have been reduced, by manipulation or operation, a shoe with the sole and heel wedged on the inner side should be worn for a year, to keep the foot in an overcorrected position, and prevent the formation of a traumatic flat-foot.

Tarsal and Metatarsal Bones.—Any of these may be fractured, usually as the result of crushing accidents. Treatment must be carried out on general lines. As it may be many months before the patient will be able to walk comfortably without a limp, the prognosis should be guarded.

One fracture requires special notice—fracture of the astragalus in which the patient falls from a height on to his feet. The tibia chops the astralagus into two halves, an anterior and a posterior, and one or other of these gets squeezed out and lies dislocated and almost free under the skin. Treatment consists in removal of the displaced half by operation. Graeme Anderson* has collected twenty of these cases following aeroplane crashes.

* "Medical and Surgical Aspects of Aviation."

CHAPTER VIII

DISLOCATIONS AND INJURIES TO JOINTS

1. Dislocations.

Shoulder.—This occurs in falls on the shoulder or as the result of "overabduction"; a man slips and falls forwards on the ice, and out go his arms; or, again, a person falls and catches hold of something to save himself by. The sudden wrench tears the lower part of the capsule, and there is nothing to keep the bone in the glenoid cavity. The patient falls to the ground and is picked up, and his arm falls or is put to his side; the bone should go back into the glenoid cavity, but it does not: it swings on the coraco-humeral ligament, and remains close beneath the coracoid process, forming a subcoracoid dislocation. If the injury is very severe the coraco-humeral ligament may be ruptured, the head of the bone sinking into the axilla.

The rounded contour of the shoulder is lost, a hollow is felt beneath the acromion process, and the elbow cannot be brought to the side; the patient is in great pain. If seen immediately after the accident, the dislocation can be reduced without an anæsthetic, using Somer's modification of Kocher's method. If only seen hours afterwards, an anæsthetic should be given, the same method being employed. In this method the bone is got back into place, not by force, but, as it were, by a trick or knack, depending on the presence of the strong coraco-humeral ligament, which slings the ligament to the coracoid process.

In the case of a right dislocation, the patient lying flat on his back on the floor, the surgeon kneels facing him, in the space between the abducted upper extremity and the

body, grasping the hand with his left and the elbow with his right hand. He flexes the elbow to a right angle, and then rotates out the humerus, using the forearm as a lever, the elbow being kept pressed against the patient's side and the floor until the hand also touches the floor. This has the effect of twisting up the ligament and bringing the head of the bone on a level with the glenoid cavity. Still keeping the arm fully rotated out by pressing down the hand, the elbow is made to describe an arc over the patient's chest until it is opposite the sternum—this moves the head of the bone from the inner side to the front of the socket—when, on suddenly releasing the leverage of the forearm and rotating in, carrying the hand on to the left shoulder, the humerus slips back into place. If this is not successful at the first attempt, it usually is at the second or third.

If still unsuccessful, even with the patient under an anæsthetic, simple manual extension upon the limb in the fully abducted position may cause reduction, an assistant making counter-extension by means of a towel passed round the chest across the right axilla.

Some dislocations reduce themselves almost; thus, the movements caused by undressing the patient preparatory to manipulation often bring about a reduction. After reduction the wrist should be tied to the neck in a Thomas's sling under the clothes, and the arm bandaged to the body. After a week the bandage may be left off, and after two weeks an ordinary sling allowed. After three weeks, if all signs of traumatic synovitis have disappeared from the joint, the patient may be allowed out of the sling altogether. So-called passive movements of the shoulder-joint should be avoided: they only keep up the traumatic synovitis caused by the accident, and delay cure. Daily stroking of the shoulder for ten minutes will assist the healing process. Violent movements and painful massage will often result in keeping up the inflammation, and in producing adhesions in the joint. The proper treatment is *rest to the inflamed parts.*

Recurrent Dislocations.—Occasionally the dislocation re-

curs again and again, on the patient raising his arm above his head, as in brushing his hair or putting on his coat. The cause of this is a large rent in the capsule, usually in front, through which the head slips. Various treatments have been devised for this, such as cutting down on the capsule and sewing up the hole, or taking a tuck in the capsule, or wearing a leather straight-jacket to prevent abduction of the arm.

Probably the best remedy is what may happily, though wrongly, be described as a homœopathic one. When the dislocation occurs it must be reduced, and the arm strongly manipulated and forcibly massaged daily to aggravate the traumatic synovitis in it. This is then gradually allowed to subside, leaving a slightly stiff yet "dislocation proof" shoulder.

Elbow.—This usually consists of a dislocation backwards of the radius and ulna on the humerus. It can be easily reduced by giving an anæsthetic and forcibly flexing the elbow, when the bones slip back into place. The elbow should be kept flexed at 80 degrees in a Thomas's sling until all signs of inflammation (traumatic synovitis) have subsided—*i.e.*, until there is no heat, pain, redness, or swelling—and until the patient is able, when the sling is removed, to extend the elbow for, say, 30 degrees, and voluntarily bring it back again into the flexed position in which it has been treated. Great harm may be done by forcibly moving the elbow every day "to prevent adhesions from forming"; adhesions will not form if the joint is left severely alone; it is movement which causes them. Disappearance of the symptoms is assisted by daily gentle stroking for ten minutes of the whole limb from the wrist to the shoulder, without removing the sling.

"*Pulled Elbow.*"—This is a common accident in children, caused by the mother pulling the child forcibly along by the hand, and perhaps shaking it because of naughtiness. The head of the radius slips partly through the encircling orbicular ligament, and the child complains of pain in the limb, and is quite unable to use it until the surgeon flexes

the elbow and gently rotates the radius first one way and then the other, when the head slips back with a click. A few days' rest in a sling completes the cure.

Hip-Joint.—Numerous dislocations of the hip are described, but I have never seen any except a dislocation of the head of the bone on to the dorsum ilii. This may occur when the thigh is suddenly forcibly flexed on the trunk, with the knee extended, as happens when a man is crushed by a fall of sand as he is working in a stooping position in a sandpit, or when a girl is tobogganing rapidly down a hill feet first, and one foot catches in a hard lump of snow, doubling her up. I have also seen it occur in riding accidents: the horse falls with the rider's leg under him, and levers the bone out of the socket.

Reduction under an anæsthetic is extremely easy. The surgeon takes hold of the foot and knee, flexes the knee on the trunk, abducts it 90 degrees, and brings the thigh quickly down into the extended position, when the bone flies back. Just as in shoulder dislocations the humerus is slung up by the coraco-humeral ligament, so here the femur is slung by the ilio-femoral ligament, rendering reduction an easy task. In this, as in most dislocations, the bones seem not at all pleased with their wrong position, and are only too eager to get back to normal if gently manipulated in the right way.

The diagnosis of dislocated hip is made on the history, the presence of $1\frac{1}{2}$ inches to 2 inches of shortening, rotation in of the thigh, and great pain and rigidity of the hip-joint. The application of the tape-measure after the dislocation has been reduced will confirm the return to normal position of the bone. The patient should be kept in bed for one to two weeks after the reduction, and then gradually allowed up. There is no tendency to recurrence.

Patella.—Dislocation is usually outwards, and occurs spontaneously in weak children, especially if there be genu valgum. It may occur over and over again in the same patient. It is due to slackness or loss of tone in the quadriceps, and should be treated by strengthening exercises

to this muscle—*e.g.*, leg circling (p. 88). Operative treatment, consisting of taking a tuck in the quadriceps tendon on the inner side of the patella, is sometimes advised, but is quite unnecessary. If the muscles are toned up, the dislocation will not occur again. The genu valgum, if present, must of course also be treated.

2. Injuries to Joints.

(*a*) General Remarks.

When a joint is injured in an accident, it reacts to the injury by becoming inflamed. The signs of this inflammation are pain, distension of the synovial cavity with fluid, heat, limitation of movement, redness of the skin, and, in a severe case, œdema of the skin and underlying tissues. The joints commonly affected by this "traumatic inflammation" are the shoulder, elbow, wrist, hip, knee, and ankle; but of these it is usually only in the knee that the condition is recognised for what it really is, and given appropriate treatment. In the knee the symptoms of synovitis, or "water on the knee," are so obvious that they cannot be missed nor their significance disregarded; but elsewhere the symptoms are not always so obvious, are not all present at one and the same time to the same degree, have attention directed away from them by other more noticeable injuries, and are modified by anatomical peculiarities, so that they are frequently missed altogether or mistaken for something else, and all sorts of unsuitable treatment prescribed for them. We have only to recognise that all injured joints are inflamed joints, and that the treatment of them is to be carried out in accordance with the same principles, to achieve at one step a tremendous advance in this domain of surgery. At present the treatment meted out to these cases is timid, contradictory, unknowing, and often brutal. A doctor will keep an inflamed *knee* at rest, but when he meets the same condition in the elbow he insists on moving it daily for fear of adhesions forming; apparently what is good for the knee is bad for the elbow.

When he gets the same condition in the shoulder, he either diagnoses it as inflammation of the subacromial bursa, or, much more commonly, as osteo-arthritis of the shoulder; owing to his teaching when a student he has never heard of synovitis of the shoulder-joint, and so does not look for it. When he is confronted with the same trouble in the wrist, a very frequent complication of an ordinary Colles's fracture, he ignores the condition altogether. In all cases except in the knee he is apt to order massage and movements, which latter are carried out in spite of the pain caused to the patient, and in spite of his protests.

The *treatment* of *all* injured joints is by immobilisation in the ideal position, until all signs of inflammation have disappeared, whether this takes weeks or months. This ideal position varies with each joint, the object being to place it in such a position that of the muscles controlling it the weaker shall be favoured.

Those ignorant of this method will at once ask, "But what about adhesions? Aren't you afraid of getting stiff joints?" To this the reply is most emphatically, "No, I am not afraid, and you need not be. You are not afraid of producing adhesions or stiffness in an inflamed knee by resting it, then why be afraid when treating an exactly similar condition in the elbow?" Thomas has summed up the correct treatment in two illuminating sentences: "The most effectual method of avoiding ankylosis is the practice of uninterrupted and prolonged immobility." "The more an inflamed joint is uncontrolled the stiffer does it become, while the more effectively it is fixed the sooner and the more complete is its capability of movement restored."*

The adhesions which form in joints after simple injuries are due to wrong treatment—viz., failure to immobilise and the use of passive movements. When full range of movement is not at once regained after injury to a joint it is a sign that the joint surfaces are not yet sufficiently recovered to allow of it: the muscles are, in fact, on guard

* "Diseases of the Hip, Knee, and Ankle Joints," 1876, p. 172.

to prevent such movement, which would be harmful to the joint. It is not a sign that the joint is becoming stiff, or that adhesions are forming, but a sign that the joint has not yet completely healed, and that a further period of rest must be given it. If we start passive movements we only aggravate the inflammatory condition and prolong the period necessary for complete recovery.

(*b*) Injuries to Particular Joints.

The Knee.—After a blow, or fall, or wrench, or after unaccustomed use, as, for example, going a fifty-mile bicycle ride after not having ridden for a year, the knee becomes swollen, hot, and painful, especially on attempting to move it, and is held slightly flexed. The swelling is due chiefly to distension of the synovial cavity with fluid, but in a severe case is also caused by œdema of the soft parts. The fluid intervenes between the patella and the femoral condyles, lifting it off them. When gently pressed upon, the patella can be made to touch the condyles, the fluid being squeezed away into the other parts of the joint; on removing the pressure the fluid rushes back, again lifting the patella. This is known as the "dancing patella" sign.

Treatment consists of rest *in bed* with the knee slightly flexed (10 degrees) on a pillow, with fracture-boards beneath the lower half of the mattress to prevent it sagging, and a large cradle over the knee and foot to keep off the bed-clothes. If sleep is disturbed, a sandbag on either side of the joint may render the patient more comfortable. The patient may sit up in bed, or turn on one side if he likes, but he must not get up. He is told to move his foot at the ankle frequently to prevent foot-drop. In the large majority of cases this treatment will cure the condition in one or two weeks, without anything further being done, and the patient can then gradually be allowed up without return of symptoms.

In a few cases other methods are adopted in addition. Thus the swelling is sometimes an outstanding feature, and

takes a long time to absorb; absorption may be hastened by raising the foot of the bed on 6-inch blocks, and by firm bandaging of the knee over wool, or by the use of a Martin's rubber bandage. Massage, consisting of Lucas-Championnière's gentle stroking of the whole limb from the toes to the hip for ten minutes morning and evening, may be beneficial in reducing the inflammation. Occasionally fixation in a Thomas's knee bed-splint may be found necessary.

Where the traumatic synovitis accompanies severe injuries to the knee, such as rupture of ligaments or fracture of patella, the same treatment is carried out, the injuries being dealt with as the inflammation subsides.

Diagnosis.—The diagnosis of simple traumatic synovitis of the knee from the synovitis accompanying severe injuries is not always easy. Quite often a case is treated as a simple synovitis, and only later is an accompanying severe injury discovered, much to the patient's distress. To guard against such an occurrence, (1) a radiogram should be taken immediately in practically every case. This will reveal fracture of patella, spine of tibia, head of tibia, or femoral condyles; will show the presence in the joint of effused blood or a loose body, and may furnish evidence that a semilunar cartilage is displaced. (2) The history of the injury should be carefully gone into and questions put—thus: Has the patient ever suffered from an injury to his knee like this before ? In what position was the limb when the injury occurred ? Was he able to straighten the knee immediately after the injury ? Was he able to go on with what he was doing, or was he carried home ?—and so on. (3) A careful examination should be made of the joint to discover if there be any limitation of movement or abnormal mobility.

These different points are contrasted in the table on p. 130.

Its diagnosis from other conditions must now be considered at some length.

There are two rare conditions which must not be confused

with it—sudden effusion of blood into the joint in hæmophilia, and acute Charcot's disease: in the one, there will be a previous history of bleeding; and in the other, signs of tabes will be discoverable.

A quite common trouble which is frequently mistaken for synovitis is traumatic inflammation of the *sub-patellar*

Fracture of Femoral Condyle, Tibia, Patella.	*Rupture of Crucial Ligaments.*	*Rupture of Lateral Ligaments.*	*Rupture or Displacement of Semilunar Cartilage.*	*Loose Body in Joint.*
Radiogram shows fracture.	1. Radiogram shows effusion of blood into joint, and perhaps fracture of spine of tibia. 2. Abnormal antero-posterior mobility of tibia on femur.	Abnormal lateral mobility of tibia on femur.	1. History of "locking" of knee in slightly flexed position. 2. Knee may be still "locked" when examined; manipulation may suddenly "unlock" it. 3. Radiogram may show increased space between one femoral condyle and tibia.	Radiogram shows it.

pad of fat (Fig. 44). This is a mass of fat, larger than the patella, filling in the space between the bones, bounded behind by the femoral condyles and crucial ligaments, in front by the ligamentum patellæ, above by the patella, and below by the head of the tibia. After a fall or blow this becomes inflamed, and inflammation of this may

accompany traumatic synovitis of the joint. After the latter has almost entirely cleared up this may persist and

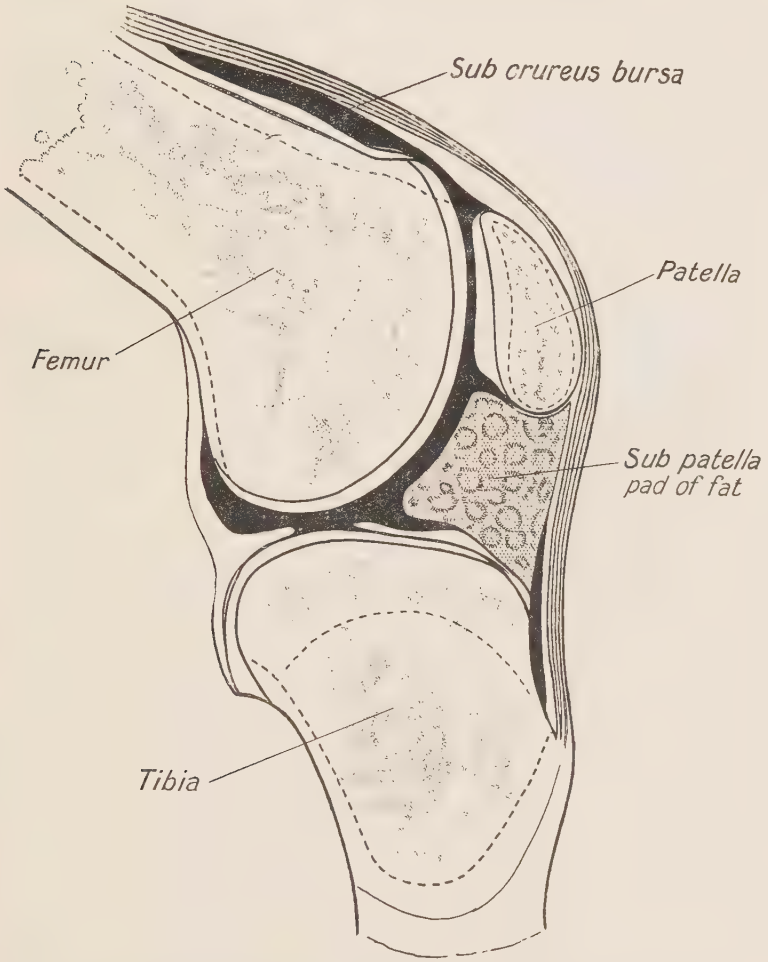


FIG. 44.—A MEDIAN VERTICAL SECTION THROUGH A KNEE-JOINT, SHOWING THE SUB-PATELLAR PAD OF FAT (AFTER W. SPALTEHOLTZ).

give some difficulty in diagnosis if not thought of. The symptoms are localised pain and swelling in front of the knee-joint below the patella; the part is hot to the touch

and tender to pressure. Walking up and down stairs makes the trouble worse. The patients often complain of the knee hurting in bed. The trouble may not get quite well, even if rested, because the pad of fat gets squeezed every time the knee is completely straightened or flexed beyond a right angle. Treatment consists in placing the joint in a "knee cage" (Fig. 45), arranged to prevent complete extension and flexion beyond a right angle. The patient walks about with the cage on for a few months, and the trouble gradually disappears as the inflammation subsides.

FIG. 45.—KNEE CAGE.

Measurements. — State left or right; trace knee horizontally down both sides 5 inches each way above and below knee-joint; circumferences above and below knee at four levels.

Gonococcal Infection. — This may simulate a simple traumatic synovitis, especially when the patient is inclined to be reticent. I have known a medical student produce a most circumstantial story of a fall to account for a swollen knee, even going to the trouble of making a mark on the staircase to show where he struck it! The meatus must be examined for discharge, and in a suspected case which does not clear up, some of the fluid may be withdrawn from the joint by aspiration, and culture of the gonococcus obtained from it. (Treatment of gonococcal knee is fixation in a Thomas's knee bed-splint and vaccine.)

Finally, tubercular disease of the knee may start as a simple synovitis. For diagnosis, see p. 61.

NOTE.—The writer has no use for tincture of iodine painted over the joint, or for Scott's dressing. Apart from their futility, these applications discolour the skin, and, being irritants, cause a mild inflammation of it. It then becomes impossible to tell whether the heat and redness present are

due to the application or to traumatic synovitis. Thus a valuable diagnostic sign is put out of court, often to the patient's detriment.

The Hip.—Traumatic synovitis of this joint seldom gives rise to much difficulty. It occurs after dislocation and sprains, and is treated by rest in bed for one or two weeks, with a pillow placed transversely under the knees to slightly flex the hip-joints, and with the limbs loosely bandaged together to limit movement.

In children it may be the starting-point of tubercular disease.

The Ankle.—Here the condition constitutes the common "sprained ankle," and also accompanies fractures of the malleoli, lower end of tibia, and astragalus. A radiogram should be always taken to decide whether a fracture is present or not.

Treatment should consist of rest in bed until the signs of inflammation have subsided. These are the usual ones of pain, heat, swelling, stiffness, and tenderness on pressure over the lateral ligaments, and at either side of the tendo Achillis where the distended posterior part of the capsule presents itself.

In all severe cases the limb should be placed in a right-angled tin night-shoe, or on a short back-splint with a foot-piece, to prevent foot-drop occurring, the patient being ordered to keep the knee bent so as to slacken the tendo Achillis. Daily stroking for ten minutes morning and evening is very soothing, and hastens recovery. The patient must be warned that it may be several weeks or even months before he will be able to get about again.

Shoulder.—For description of traumatic synovitis of this joint, see p. 66.

Elbow.—Injury to this joint is a frequent result of a severe sprain or dislocation; it complicates fracture of the lower end of the humerus or separation of its lower epiphysis, or fracture of the olecranon. In considering treatment, let us take as an example of the condition an elbow which has received a severe wrench. The elbow is swollen, red,

hot, and painful, and is fixed at an angle of 120 degrees, the angle at which all recently injured elbows are held. The proper treatment is to fix the elbow at an angle of 45 degrees in the Thomas's sling, and keep it there, under the clothes, until all signs of inflammation have disappeared, and until the patient is able to flex it fully without pain. (It may not be possible for the first day or two, because of the great swelling, to bend the elbow to less than a right angle; but soon the swelling goes down, and the required angle of 45 degrees can be obtained by shortening the sling a little bit every day.) Gentle stroking assists absorption of the effused serum. On no account must the elbow be forcibly moved every day "to prevent adhesion from forming." Leave it alone in the ideal position, and it will get well by itself.

Wrist.—Here, again, rest to the joint is everything. All that is needed is to bandage the limb into a dorsiflexed wrist-splint, and apply an ordinary sling.

(*c*) Microbic Infection of Joints.

Any joint may become infected with micro-organisms as the result of wounds or compound fracture, or after specific infectious disorders—*e.g.*, pneumonia, gonorrhœa. More than ever must the treatment be by absolute immobilisation in the ideal position, for the chance of ankylosis resulting is considerable, and if it does occur, it is at least possible to ensure that it shall take place with the bones in the most advantageous position for practical use. The ideal position is the same as for simple traumatic synovitis, except in the case of the shoulder. Here a humerus ankylosed to the scapula in the ordinary "arm by the side" position is of very limited use; but if the ankylosis be allowed to occur when the arm is abducted 45 degrees, a quite useful limb is obtained, the scapular muscles being able to move the fused humerus and scapula very well indeed. This joint is to be treated, then, when ankylosis is feared, with the

wrist in Thomas's sling, and the elbow kept out from the side by a small pillow, supported by a strap over the opposite shoulder.

If both elbows are affected, the right should be treated at an angle of 45 degrees, but the left at 110 degrees; if both become subsequently ankylosed, the patient will be able to drink, holding the glass in the right hand, and will be able to stretch across the table with the left one. He will also be able to use the left hand for adjusting his dress in the lavatory.

When the joints become distended with purulent fluid, they must be aspirated. If actual pus form within the joint, suitable incisions must be made for drainage. Though a dangerous symptom, the presence of pus by no means renders the case hopeless provided the joint is kept immobilised; thus, a child with many ounces of pneumococcal pus in her right knee recovered completely with full normal movement.

This is a suitable place to point out that an ordinary back-splint with foot-piece does not immobilise a knee-joint efficiently: it does not extend far enough up past the knee to do so. A Thomas's knee bed-splint should be used in every case.

(*d*) Internal Derangements of the Knee-Joint.

There are three fairly common conditions which must be recognised:

1. Loose cartilage.
2. Rupture of crucial ligaments.
3. Presence of loose body.

The differential diagnosis of these has been already dealt with.

1. **Loose Cartilage.**—Though the internal cartilage is the one usually injured, either cartilage may be affected.

The cartilage is loosened, and thereby allowed to get displaced, in one of three ways:

(*a*) The cartilage is ruptured right across, with some tearing of the coronary ligament which should moor it to the capsule, so that one or both of the broken ends are free to slip in between the femur and tibia.

(*b*) The anterior end is detached from the tibia, with rupture of its attachments to the transverse and coronary ligaments, and is free to get between the bones.

(*c*) Its attachment to the coronary ligament is ruptured, the ends of the cartilage remaining attached, so that a loop of the cartilage, as it were, is able to slip about in the joint and get nipped.

The accident of injury to the cartilage is always due to a sudden strain or wrench of a twisting kind with the knee bent—*e.g.*, turning quickly round in such games as tennis or football, or slipping off the kerbstone or into a shell-hole. It only occurs when the knee is bent, as it is only then that any rotation is possible between the tibia and femur. As the twist takes place, the cartilage or its attachments snap, and the detached portion slips in between the articular surfaces, and prevents the knee from being straightened. This is known as "locking" of the joint, and is very painful. Suddenly or gradually the cartilage slips back again into position and the pain is relieved; but this is not the end of the trouble, for there is an immediate and remote effect. The ruptured portion becomes swollen and inflamed, with accompanying traumatic synovitis of the joint; under careful treatment by rest and immobilisation the parts may heal together again, and the patient be nearly as well as ever. But there will always be a weakness at the spot, and the patient will be always more liable than a sound person to suffer from a displacement. If not correctly treated, or if the injury be very severe, the damaged parts do not heal, but remain detached and frequently slip out of place, each time causing locking and subsequent synovitis of the knee.

It sometimes happens that the displaced portion does not go back, but remains out, locking the joint for months at a time, and preventing the knee from being straightened. A simple manipulation on the part of the surgeon can reduce it, but often, most unaccountably, he does not recognise what is wrong, and the patient is taken to a bone-setter, who at once puts the matter right, to the detriment of the surgeon's reputation. The manipulation is carried out as follows: The patient lies on his back on a couch; the surgeon takes hold of the leg just below the knee with one hand, and the foot with the other, and slowly flexes up the knee towards the patient's chest until it is bent to an angle of 60 degrees; he then rapidly extends it, at the same time forcibly rotating the foot and leg outwards on the femur, when the cartilage slips back into place with a sudden jerk, and the knee comes quite straight. This hurts the patient momentarily; but after it he is entirely relieved of his discomfort, and can straighten the limb completely and walk from the room without a limp. If the manipulation is not successful, it should be repeated, but this time the foot and leg should be rotated inwards. If still unsuccessful, the complete muscular relaxation obtainable under an anæsthetic may be necessary before reduction can be accomplished.

After-treatment consists of the treatment described for traumatic synovitis of the knee. The patient is warned to take great care in going up and down stairs, and to avoid all athletics for some months. The injury may then heal soundly, and he may never be troubled with it again. If, however, he suffer a second or third attack of displacement, it is unlikely that a cure will be obtained without operation. Before deciding on this, however, the patient should be given a final chance by fixing the knee in a "cage" for six months, and observing if displacement occurs again. If it does not, well and good; but if it does, then operation should be advised without further delay.

Operation consists in seizing the loose fragment of cartilage with a pair of Lane's tissue-forceps, and cutting it away with

a sharp knife from the remaining fixed and healthy portions. Only loose or diseased portions of the cartilage are to be removed; there is to be no tearing out of the cartilage by the roots; the cutting must be clean. Some surgeons by their violent efforts at tearing out the cartilage only detach still more of it, and thereby cause fresh trouble in the joint, for which the patient has to suffer afterwards.

As regards the route adopted for entering the joint, I now always use the median patellar one, splitting the patella vertically into two lateral halves, and drawing these aside. This gives a good view of *both* cartilages, and enables the loose part of the one affected to be cut cleanly away. (See author's paper, *Clinical Journal*, March, 1918.) Throughout the operation, which is only to be done by an experienced surgeon, the principles practiced by Lane in bone-plating must be strictly adhered to.

After-treatment is as for traumatic synovitis of knee. In the course of two or three months the patient is back at his usual work. It is remarkable that the knee can function with a piece of semilunar cartilage missing; in all probability the gap fills up with fibrous tissue, which eventually takes on the characters of the original cartilage; a post-mortem examination on a case some years after the operation does not seem to have been made.

2. **Rupture of Crucial Ligaments.**—Usually the anterior ligament is ruptured; occasionally both. It occurs as the result of a sudden great strain, wrenching the tibia away from the femur, as in riding accidents and aeroplane crashes; it is also described as happening in railway-train collisions—the carriage telescopes, and the edge of the seat opposite the sitting passenger is suddenly jammed against the upper end of his tibia, knocking it backwards on the femur.

The immediate result is great pain and increased mobility in the knee. The joint rapidly fills with blood, and the knee becomes tremendously swollen. A radiogram shows the presence of blood, and perhaps a fracture of the spine of the tibia. Treatment should be as for acute traumatic

synovitis of knee. If the diagnosis is clear, an exploratory operation should be done at the end of a week, and an attempt made to repair the damage by suture. If a portion of the spine is detached it may be possible to replace it, or it may be better to excise it altogether. The median patellar route should be used in every case. Operation months after the injury is not likely to be successful, and unfortunately it is often not till then that the case is correctly diagnosed. (Let me here repeat that in all marked cases of traumatic synovitis a radiogram should be taken early.) In these chronic cases, the patient can at will partially dislocate the femur forwards on the tibia in an alarming manner, and the joint is always slightly hot, swollen, and painful. The only treatment is fixation. This is conveniently done by an apparatus consisting of two lateral irons, jointed at the knee, and fixed to the limb by a leather thigh-piece above and a leg-piece below, which both lace in front (Fig. 46). At first any movement in the metal joints is prevented by a stop, which later on can be filed away gradually. Thus, after the patient has worn the apparatus day and night for six months, and is able at the end of that time to walk a mile or so without pain and without the knee getting swollen or hot, it is safe to have enough of the stop filed away to allow 30 degrees of movement. At the end of, say, another three months, if everything remains favourable, more movement still may be allowed, and so on until a cure is achieved, or as much movement is allowed as can be tolerated by the patient—for some of these cases will require to wear an apparatus to limit flexion for the rest of their lives.

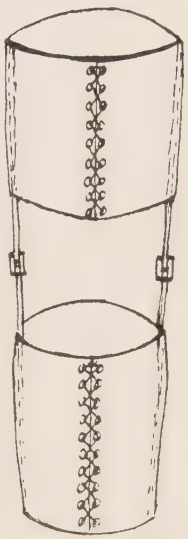


FIG. 46.—MOULDED LEATHER KNEE-SPLINT.

A plaster cast is made of the leg and calf, and the leather moulded over it.

3. **Loose Body in Knee-Joint.**—Loose bodies may occur as a result of—

(1) *Chronic hypertrophic osteo-arthritis,* where an osteophyte becomes detached.
(2) *Trauma,* such as a blow on the front of the tibia, where a fragment of bone is chipped off.
(3) Chondrification or ossification taking place in hypertrophied joint villi.
(4) The process known as "*osteochondritis dissecans,*" where a portion of bone gradually becomes separated off one condyle.

There may be one loose body, or two, or more. They apparently lie *perdu* in some crevice or hollow of the joint for a long time, giving rise to no trouble, until one day they suddenly slip out and get nipped for a second between the articular surfaces of the bones, causing the patient a sudden sharp pain. Though they may slip back again at once, the momentary nipping always produces an attack of traumatic synovitis. Having once acquired the habit of slipping out, they do so more and more frequently, and the patient never knows when he may suddenly have a painful attack. The treatment is removal by operation. Sometimes this is very easy, as where the loose body slips into a position where it can be felt on palpation; it is then transfixed aseptically with a stout needle to prevent it from slipping away, and removed through an inch long incision. Sometimes, on the other hand, it is difficult, as where it lies at the back of the joint, and cannot be palpated or manipulated to the front. Careful radiograms must be taken to decide upon its position. In this connection one must remember not to mistake a sesamoid bone, which is often present in the tendon of the outer head of the gastrocnemius, for a loose body. The former is oval in shape when seen from the side, with its long axis placed vertically; is as dense to the X rays as the densest part of the femur, tibia, and patella; is situated behind a line joining the most posterior portions of the tibial head and femoral condyles

as seen in the lateral radiographic view, and well to the outer side of the mid-line in the antero-posterior view. The latter may be of any irregularly rounded shape, is not as dense to the X-rays as the densest parts of the other bones, and may be anywhere in the joint cavity.

In operating, the median patellar is again the best means of approach, as it allows a complete examination of the joint. If the loose body is lying at the back, it can be hooked forwards with an aneurism needle. It often happens, however, that when the knee is flexed and extended alternately two or three times the loose body is squeezed out of its position at the back and is rolled forwards to the front, so that there is no difficulty in removing it at all. A posterior incision should not be made unless the loose body can actually be palpated behind.

Removal of the body results in complete cure of the symptoms.

Note.—Precisely similar loose bodies occasionally occur in the elbow-joint.[1]

[1] See footnote on p. 127.

CHAPTER IX

INJURIES TO PERIPHERAL NERVES

Peripheral nerves may be injured by blows, wrenches, incised or lacerated or gunshot wounds, and by pressure of misplaced bones or of splints and crutches.

They are affected as a result in one or more of the following ways:

Group I.

1. Complete destruction or obliteration of a nerve for a considerable portion, even inches, of its course.
2. Complete division.
3. Partial division.
4. Involvement in scar tissue. (This is the commonest.)
5. Involvement in callus following fracture.
6. Pressure by a malunited fragment, following fracture.
7. Pressure by a lodged bullet or other foreign body.

Group II.

8. Bruising.
9. Concussion.
10. Traumatic hysteria.

When the case is first seen, the particular variety of injury must, if possible, be diagnosed, as on this depends the treatment. In making the diagnosis, the following examinations may be necessary:

1. **Examination of the Wound, if any.**—If it be incised or lacerated, the ends of the divided nerve may be seen

lying in it. When the flexor tendons at the wrist are divided by the hand being thrust accidentally through a window-pane, the median nerve is often injured, and at the operation done to suture the tendons this must be borne in mind, for it has happened that a severed median nerve has been sutured to a divided tendon, much to the subsequent mortification of the young surgeon, not to mention the patient.

The *position* of the wound in relation to the course of any particular nerve may at once draw attention to the possibility of its being injured.

2. **Examination for the Presence of Deformity.**—Very often one can tell at a glance which nerve is affected. Thus, wrist-drop indicates injury to the musculo-spiral; claw-hand, injury to the ulnar; foot-drop, injury to the sciatic or external popliteal; winged scapula, the nerve to the rhomboids; the mouth drawn to one side, injury to the opposite facial, and so on.

3. **Examination of the Patient's Power of Voluntary Muscular Movement.**—A systematic examination is made of all the movements normally possible, the patient being asked, say, to flex, extend, adduct, abduct, etc., as the case may be; inability to perform any of these movements points to the muscles probably affected, and so to the injured nerve. In making the examination it must not be forgotten that apparent complete paralysis may be due simply to disuse; whether this be so is discovered by testing electrically (see 5).

4. **Examination of the Skin and Cutaneous Sensation.**—When for some months an area of skin has been cut off from its nerve, trophic changes are produced in it, such as shrinkage, glossy appearance, loss of hair, formation of ulcers, etc. The finding of such changes in any particular region at once tells us that the nerve to that part is affected. Then, again, certain nerves supply definite areas of skin with sensation; if such an area is found to be anæsthetic the nerve supplying it must be injured. The whole skin of the affected part must be tested for sensitivity to "light

touch" and pin-prick. When the area of loss of sensation does not follow the distribution of a nerve, but is of the type known as "glove anæsthesia," it is evident we are dealing with a case of traumatic hysteria (hysterical paralysis).

5. **Radiographic Examination.**—This reveals the site of fracture, the presence of callus, or the abnormal projection of a fragment of bone. It also locates a lodged bullet or other foreign body.

6. **Electrical Examination of the Muscles.**—A set of Lewis Jones condensers is used, made by Schall and Son,

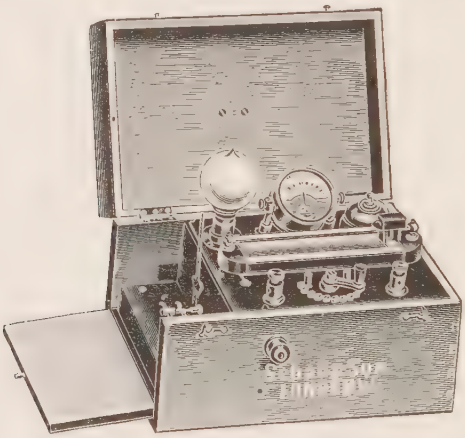


FIG. 47.—LEWIS JONES CONDENSER SET.

as suggested by Dr. Purves Stewart (Fig. 47). A series of ten capacities, ranging from 0·025 to 3 microfarads, with a dial and switch for putting them in action, are mounted in a box, together with a metronome device for alternately charging them from a continuous current, the main, and discharging them into the patient's muscle. The current is kept down to 100 volts by means of the lamp and sliding contact resistance, controlled by the voltmeter. The dial has ten studs, numbered for convenience 1 to 10—No. 1, the lowest, putting into action the condenser with a capacity of 0·025 microfarad, and No. 10, the highest, that with a capacity of 3 microfarads.

If, when the electrodes are applied to it, a muscle reacts to one of the first three studs, it is considered normal electrically, and the nerve supplying it is healthy; if only to one of the next four, it exhibits the reaction of incomplete degeneration, and the nerve supplying it is partially injured; if only to one of the last three, complete reaction of degeneration is present, and the nerve is so badly damaged that no impulses whatever pass along it. In practice, the terms "faradic" or "galvanic" stimulation, reaction of "complete" or "incomplete" degeneration, are dropped, as being of little value, and instead a muscle is referred to as acting at so many microfarads, or at such-and-such a stud on the dial.

This instrument has three uses:

1. For diagnosing which muscles are cut off from their nerves, and determining their excitability in measurable terms.
2. For testing by observations made with it at fixed intervals of time whether the lesion is recovering, remaining stationary, or progressing.
3. For daily treatment.

The frame of mind of certain observers who persistently refuse to make use of this beautiful apparatus, sticking instead to the old inaccurate "galvanic" and "faradic" stimulation of muscles, is quite unintelligible.

The treatment of these injuries may be considered by asking and answering five questions.

1. **What Cases should be Operated on?**—If affected in one of the first seven ways (Group I.), the nerve will never be able to function properly unless an operation is performed; if affected in one of the last three (Group II.), an operation is not required, and is contra-indicated.

Now, although we often cannot diagnose between the individual members of Group I. until the operation is being done and the nerve trunk is laid bare, we are able to distinguish between them and those of Group II. For leaving out the hysterical cases, whose well-known features

—apparent paralysis, normal electrical excitability, and glove anæsthesia—render them quite unlike any of the other conditions, the cases in Group II. tend to get rapidly well under suitable treatment, and sometimes even without it, whereas those in Group I. do not get well, but remain stationary, or even get worse. In deciding, therefore, in any given case whether to operate or not, all that we require to know is whether the case belongs to Group I. or Group II. If the case be examined three to four weeks after injury and certain signs of damage to the nerve be present—*e.g.*, paralysis of muscles or areas of cutaneous anæsthesia, and if two weeks later the case be again examined and the paralysis and anæsthesia are present to the same degree, improvement is not taking place, the case belongs to Group I. and operation is indicated.

If, on the other hand, the muscles react more readily to electrical stimulation, and the areas of cutaneous insensibility have diminished in extent, then recovery is taking place, the case may be provisionally placed in Group II., and operation for the time being is contra-indicated. At the end of another fortnight, if there be further improvement, it becomes still more probable that the case belongs to Group II., and that operation will not be required. If the improvement steadily continues, we shall be able to state definitely that there has been no gross lesion of the nerve, and that complete recovery without operation is certain. Now and then, however, we may meet a case where improvement continues up to a certain point and then becomes stationary; such a case, which has been classified provisionally as belonging to Group II., must then be regarded definitely as belonging to Group I., and operated on forthwith. The explanation of such a case is that part of the paralysis is due to concussion or bruising, and part to some gross lesion; that due to the former has now cleared up, while the latter has persisted.

All old cases should be operated on at once—*e.g.*, a case of marked claw-hand or glossy fingers—without waiting

to see if they get better; too much time has been lost already. There should be no exceptions; even if the injury be high up in the sacral or brachial plexus, an operation may relieve; we cannot tell till we cut down and dissect out the nerves exactly what we shall find. In one case the division of a constricting band of scar tissue may be all that is necessary; in another, the nerve trunks may be found hopelessly obliterated, and there is nothing to do but close the wound.

Every case, then, should be given its chance. If the condition is one that can be relieved, every day of delay may be costly.

In examining these cases, with a view to noting the onset of recovery, numerous fallacies will arise unless the greatest care be taken to eliminate the personal factor. Thus, the two or more examinations of a case must be made by the same observer, in the same room, at the same warm temperature, at the same time of day. In testing for cutaneous sensibility the rules laid down by Sherren[1] must be strictly adhered to.

2. **When should the Operation take Place?**—Immediately after receipt of the injury if possible (primary suture), or not until the wound has soundly healed (secondary suture). In the case of cut tendons with division of the median nerve, already cited as an example, the sooner the operation is done the better, certainly not later than the following day. The earlier the suture is performed the quicker will recovery take place. Also, the earlier the operation is done, the less is the chance of sepsis. If sepsis has set in, suture of the nerve is contra-indicated until all trace of it has disappeared for some time—that is, until the wound has healed soundly. Some surgeons advise waiting three to six months later than this, to avoid the chance of again setting up sepsis; but this is unnecessary. Moreover, in the large majority of cases due to gunshot wounds the nerve is not completely or even partially severed, but only compressed by the contracting scar. The longer this state of compression is allowed to last, the greater is the damage

produced in the nerve. The sooner the operation is performed, the better for the patient.

It is never too late to do the operation; the earlier it is done, the better; and the longer it is put off, the less good will result from it; but it will nearly always do some good. As said before, every case should be given its chance.

3. **What Operation should be Performed ?**—In the case of a nerve divided, say, a few hours before, the two ends are dissected clear, brought end to end, and sutured together with linen thread as accurately as possible (primary suture). In the case of an exploratory operation done after the wound has soundly healed, where possible the nerve should be dissected out of the scar or callus, and if its fibres appear anatomically sound (Fig. 48, *a*), it should be dropped back into the wound and the latter closed. If the nerve be partly severed and partly unhurt (Fig. 48, *b*), the severed portions should be freshened and sutured together, leaving the unhurt portion intact. To divide unhurt fibres and thereby increase the paralysis, as has been done in one or two published cases, seems purposeless and regrettable. When the nerve is completely severed (Fig. 48, *c*) the two ends are dissected clear, freshened by cutting through them where they are apparently healthy, and joined by suture with linen thread (secondary suture). It may be noted that much more tissue requires to be cut away from the proximal end than from the distal. When the gap is large it can usually be bridged by freeing each end from its sheath for several inches; then, by gently tightening the sutures, the two ends can be brought together without harmful stretching. A gap of 3 inches can be filled in this way. The knee or elbow, as the case may be, can also be temporarily flexed to help in the closure of the gap by relaxing the tension.

Where there is not anatomical division, but a so-called neuroma on the course of the nerve (Fig. 48, *d*), this should not be excised unless it clearly involves the whole of the nerve at that spot; if any fibres can be seen passing it, it should be left alone. Before excision the prognosis of the case is that recovery may be hoped for in some months; after

excision, recovery becomes a matter of years. If no recovery follows the conservative operation, the neuroma can always be excised later. In deciding whether to excise a neuroma or not, we may be guided further at the operation

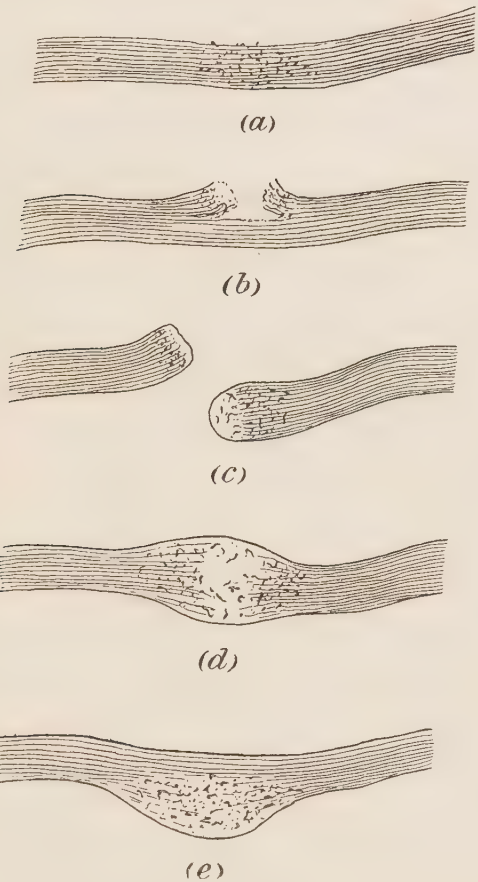


FIG. 48.—DIAGRAMS REPRESENTING A NERVE.
(*a*) Involved in scar; (*b*) partly severed; (*c*) completely severed; (*d*) involved in a "neuroma"; and (*e*) partly involved in a neuroma.

by considering the previously ascertained electrical excitability of the muscles concerned; that they would not react to a condenser discharge of 2 or 3 microfarads would be a fact favouring excision. Some surgeons endeavour to stimulate

the nerve with electrodes as it lies exposed in the wound, and cut away any part through which a stimulus cannot be transmitted; but this method is bristling with possible fallacies, and must be used with reserve. Another method of testing a nerve is to pinch it with an artery forceps, and observe if this is accompanied by any muscular contraction. When unwilling to excise a neuroma, the operator may adopt the empirical plan of bisecting it longitudinally with a scalpel, with a view to freeing the healthy fibres from undue pressure. When a neuroma clearly involves the whole of a nerve, it should be excised, and end-to-end suture done. Lastly, any foreign body present must be removed, and any abnormal projection of bone chiselled away.

Techinque.—In operating, Lane's rules must be observed, the whole affair being conducted as if a bone-plating operation were in progress. The skin is hidden with towels clipped to the edges of the wound, and only the handles of the instruments must be touched by the operator. The fingers are not to touch the wound at all.

At one time it was the fashion to wrap the damaged nerve round with Cargile membrane[2] before closing the skin, but in most cases this does not appear needful.

4. **What Pre-Operative and Post-Operative Treatment is Necessary?** (*a*) *Pre-Operative.*—Deformity must be prevented by suitable splints worn day and night, and by daily massage and movements. If the affected muscles will react to electricity, they are made to do so daily.

Splints, etc.—For musculo-spiral paralysis, a dorsiflexed wrist-splint, with the wing bent out on the radial side, so as to form a rest for the thumb. This splint relaxes the paralysed extensor muscles without unduly stretching the flexors.

For ulnar paralysis, Sherren's splint (Fig. 49). This flexes the metacarpo-phalangeal joints, and extends the interphalangeal ones.

For circumflex paralysis, Fairbank's splint.

For sciatic or external popliteal, a right-angled tin night-shoe.

For internal popliteal alone, a rare condition, an obtuse-angled tin night-shoe.

For median nerve paralysis, in which a prominent disability is loss of power to flex the last joint of the thumb and to oppose it, the thumb should be kept flexed and opposed with a bandage.

Massage and Movements.—The importance of regular daily massage and movements in these cases must be emphasised. The treatment should consist chiefly of gentle rhythmical stroking, of gentle full movements of all the neighbouring joints, active and passive, and of gentle pinching and kneading of the affected muscles. *The surgeon should demonstrate the case fully to the masseuse,* explaining what the damage is, and what her treatment is expected

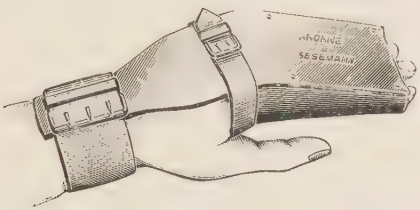


Fig. 49.—Sherren's Splint for Ulnar Paralysis.

to bring about. She must be warned in a particular case of the effects which might be produced by too much massage or movement, such as pain and cutaneous irritation, and of the deformities it is hoped to avoid. Her opinion of the daily progress of the case must be asked for, and the surgeon and she must work together. The old convenient plan of writing "massage" on a piece of paper and packing the patient out of the room must be given up.

Electrical Stimulation.—Providing a contraction can be obtained, the affected muscles are stimulated for ten minutes daily, preferably immediately following the massage and movements, using the Lewis Jones condenser set. If there is no contraction, electrical stimulation is useless.

(*b*) *Post-Operative.*—As soon as the wound is healed, the same treatment is continued with. In an ideal case,

treatment should be given daily until recovery is complete. In the lower extremity, in addition to the same treatment, a walking instrument is provided. The usual one required is a "walking instrument single to the knee with uplifting toe spring" (Fig. 12). When the internal popliteal nerve only is affected, the spring must be a depressing one. The instrument is removed at night, and the night-shoe applied. The affected muscles are thereby kept relaxed continuously.

The operation is often the least part of the treatment; it is the after-care which in most cases decides the degree of the patient's recovery.

5. **What Recovery after Operation may be Expected?**—The prognosis varies with each case. If there has been no actual anatomical division of the nerve, it being merely compressed by scar tissue, the outlook is very hopeful, and complete recovery in the course of from one to six months is to be looked for. Where the nerve has been divided at the time of injury, or at operation, as in the excision of a neuroma, recovery cannot be expected for two or three years, and though partial recovery is common, complete return of power and sensation is rare. Between these two extremes are cases of varying degrees of severity, with similarly varying prognosis.

Quite often painful symptoms are relieved immediately. Thus, in one case, unbearable pain in the sole of the foot, which had lasted three months, was relieved at once when a distorted bullet was removed from the pelvis, where it had pressed on the sacral plexus; and in another, pain and acute hypersensitiveness in the whole hand was at once abolished when the median nerve was freed from the anterior annular ligament, where it had been involved in scar.

The distance of the nerve lesion from the periphery affects the prognosis: the greater the distance, the longer will be the period of recovery,

Suppuration in the original wound is said to make the outlook worse; it does so indirectly by causing an extra formation of scar tissue, and by delaying the opportunity for operation.

Cases have been published recently in which suture of a completely divided nerve was followed in a week or ten days by improvement in sensation. This cannot be accepted as evidence that sensory impulses have already begun to pass through the sutured junction; either an inhibitory effect has been removed by the operation, or some fallacy is at work. The beginnings of sensory recovery may be confidently expected in two or three months; but the earliest beginnings of motor return cannot be hoped for until six to nine months have elapsed.

[1] "Injuries to Nerves," 1908.
[2] The sterilised peritoneum of the ox.

CHAPTER X

AMPUTATION STUMPS AND ARTIFICIAL LIMBS

When an amputation has been done, especially in the lower extremity, the patient's first thought is, when may he be measured for an artificial limb? The answer is: "*Directly we are satisfied the stump is a 'good' one.*" We may consider a stump to be "good" when—

1. The skin wound is soundly healed.
2. The cicatrix and soft parts are not tender on palpation.
3. The skin is not adherent to the end of the bone.
4. The end of the bone does not project unduly from the soft parts, and, on the other hand, when the soft parts forming the end of the stump are not too long and pendulous.
5. There is no fixed flexion (or adduction) of the stump at the joint immediately above.
6. The stump is of such a shape that it can be slipped into the bucket of an artificial limb.

If these conditions are not present, how may they be brought about?

1. If the wound does not heal, there is usually some reason for it, such as the end of the bone presenting, or the presence of sequestra, or a small stitch abscess. If the end of the bone presents, a reamputation must be done, and an inch or more of bone removed; if there are sequestra, as felt with a probe or shown by radiograms, they must be removed, and the sinuses leading to them scraped; stitch abscesses are to be laid well open, and the stitch removed.

2. If the soft parts are tender, apart from inflammatory trouble, a nerve is probably involved in scar: the scar must be excised, and the nerve found, dissected clear, and cut off short. Sometimes swellings form on the ends of the nerves (false neuromata), and give rise to pain; they are dissected out and the nerves cut off short. To guard against their recurrence a cuff, formed of the sheath of the nerve, may be dissected off it and stitched over its end with catgut.

3. When the skin is adherent to the end of the bone, reamputation must be done.

4. When the bone projects too much, the soft parts which have shrunk away can be often brought down and made to cover it by a few weeks' extension with strips of adhesive plaster. In the case of the thigh, a Thomas's knee-splint is employed, cut off short 6 inches below the end of the stump, the ends being turned in at right angles to meet each other (Fig. 50). Four broad extension strips are used—two in front and two behind; they are kept in place by several other strips applied round the circumference of the stump, and their ends having been drawn down tight, are fixed over the end of the splint with safety-pins, which are readjusted every few days as the soft parts stretch.

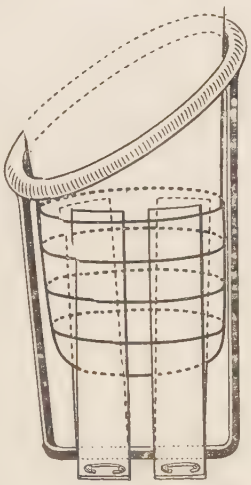


Fig. 50. — Extension made to Soft Parts of Stump with Four Strips of Adhesive Plaster, Two in Front and Two Behind.

When the soft parts are too long and interfere with the proper fitting and use of an artificial limb, they should be left alone absolutely for three months—no massage, or movements, etc.—and encouraged to atrophy. If by this time they have not shrunk sufficiently, some of the skin and muscles must be removed by operation. This trouble is usually only met with in the arm.

5. If fixed flexion (contraction) is present, it must be overcome by daily passive and active movements; if after fair trial these fail, division of the contracted muscle becomes necessary.

It is most important to *prevent* this contraction taking place, which can be done by daily exercising of the nearest joint, putting it methodically through the whole range of its movements. In the thigh, the patient must specially be made to abduct and hyperextend, as the common deformities to guard against are those of adduction and flexion. If these contractions are present, it becomes almost impossible to fit the patient with an artificial limb, as it cannot be got to lie parallel with the sound one.

6. A stump is often not much use to its owner if it cannot be fitted with an artificial limb—*e.g.*, a stump with an enlarged end, as in disarticulation at the knee or elbow joint; the only treatment here consists in reamputation just above the femoral or humeral condyles.

Reamputation.

Points to be Considered.—We want to produce a healthy stump, and we want to make a good job of the patient's limb at one go, so that he will not want another operation afterwards. There is a danger of not making the stump any better than it was before, or of causing a recrudescence of local sepsis, unless the operation is done with great care.

If there is dead bone presenting, or a discharging sinus, reamputation is a dangerous proceeding. Instead of it a preliminary operation is done, removing the dead bone, and opening up and even excising the sinus. Only when the stump is completely healed is there certainty of being able to perform an entirely aseptic reamputation. There are cases, however, where we have waited many months for the skin to heal, and where, instead of this happening, a shallow ulcer with hard edges has formed, which defies all our efforts to close it over. Reamputation can be done successfully on such stumps if the ulcer is painted with

iodine, covered with three or four layers of gauze and collodion, and the whole stump painted over with iodine again. (This sealing-up process is carried out by the surgeon himself, who then changes his gloves and washes up fresh before proceeding to operate.) In deciding where to amputate, we must be guided by consideration of usefulness. Thus it is no use cutting off the forearm bones so close to the humerus that there is practically no forearm stump left to put into a bucket; where so little can be left, the amputation must be done through the lower end of the humerus. It has already been pointed out that disarticulation should not be done at the knee or elbow.

Operation.—Apply a tourniquet. Repaint the whole limb with iodine. Mark out with the knife an elipse of tissue it is intended to remove (Fig. 51). From the two ends of the ellipse carry up a lateral incision on either side of the limb, thus marking out an anterior and posterior flap. (In the case of the leg, the incision may be anterior and posterior, and the flaps lateral ones.)

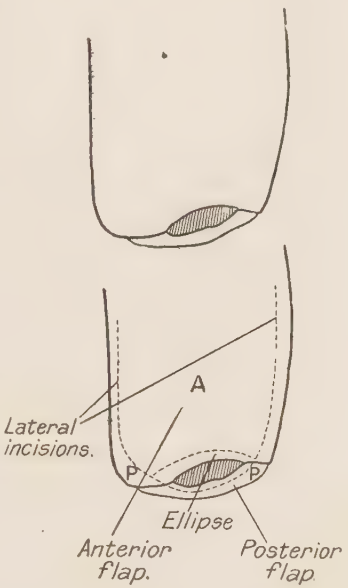


FIG. 51.—REAMPUTATION.
The shaded area is the shallow ulcer; the dotted lines mark out the two flaps and the el ipse of tissue to be removed.

The two flaps are turned back a quarter of their distance, consisting of skin and subcutaneous tissues, and then for the remaining three-quarters consisting of muscle as well. The ellipse of tissue, including the bone, is held by an assistant with a pair of Lane's large bone-holding forceps, and the bone having been sawn off at the required level, the whole is removed right away. From start to finish the ellipse of tissue, including the bone, is not once

touched by the operator, nor by any instrument he is using.

The main bloodvessels are found and ligatured, and the nerve trunks dissected clear and cut off short. The tourniquet is relaxed, and all bleeding-points secured and ligatured. The flaps are then turned down again, and the muscle layers of the two loosely sutured together over the end of the bone with a few catgut stitches. The skin edges are brought together with interrupted silkworm gut sutures, a small glove drain (strip ½ inch × 4 inches cut from an old rubber glove) being inserted at one corner and removed after two days. For cutting the bone, a jack-saw or a Gigli may be used, whichever is most convenient.

Shrinkage of the Stump.—The usefulness of a stump is much impaired by waiting for it to shrink. We want to prevent the shrinkage as much as possible, and the only way is to use the stump soon; the ideal time for the patient to be wearing an artificial limb is within a month of amputation. Shrinking will undoubtedly take place, quickly at first, and slowly later, until six months have passed, but we need not condemn the patient to six months of inactivity. A cheap temporary artificial limb is applied, and the patient persuaded to use it as much as he can. When the shrinkage is complete and the patient has learned how to use an artificial limb, the permanent limb is ordered.

Choice of a Limb.—There are several points to consider.

The Cost.—An artificial limb may be regarded as consisting of two parts—the bucket into which the stump is slipped, and which is fixed to the trunk with suitable straps; and the "business part" of the limb, which is to represent and act for the part which is missing. The bucket is essential to all, and costs much the same; but there is a very great difference in the amount of money which may be spent on the business part, which is why artificial limbs vary in price from two pounds to fifty. The patient may be content with a bucket and peg, or he may insist on an exact reproduction of the limb he has lost. Certainly the temporary limb should be as simple and cheap as

possible, so that it can be obtained quickly, and discarded without regret as soon as it no longer fits.

The Bearing of the Weight.—In the lower limb the end of the stump must not take any of the weight of the body —that is, must not reach to the bottom of the bucket—but must rest in it as a tooth does in its socket, with a free space at its root. If it is allowed to reach to the bottom, there is sure to be trouble. There is one real and one apparent exception to this, however. In the case of a Syme's amputation of the ankle, the patient can comfortably bear the whole of his weight on the end of the stump, because of the natural pad formed by the dense tissues of the heel, and can be fitted with what is known as an "elephant's foot" boot, a long cylindrical tube of leather lacing up the front of the leg. In an amputation below the knee, where, owing to less than 2 inches of the tibia remaining, there is a very short stump and a bucket cannot be applied, the difficulty is got over by making the patient flex the short stump on the femur, and kneel on a pad placed in the centre of the artificial limb. He thus takes the weight, not on the end of the stump, but on part of the tubercle of the tibia. In all other cases an "end-bearing" appliance is undesirable, for it is sure to lead to discomfort. An attempt has been made to force soldiers to accept "end-bearing" limbs, with what object it is difficult to discern. When they are told they will not be allowed to leave hospital until the limb is comfortable, they are apt to acquiesce in the surgeon putting several pads of felt beneath the end of the stump to fill up the free space, and agree it is comfortable—they have no other choice—but directly his back is turned, out come the pads.

Applying the Bucket.—In doing this, there is a tendency for the soft parts to be squeezed up away from the end of the stump, so that the end of the bone becomes very prominent, and a good fit is not obtained—the upper part of the bucket fits too tightly, and the lower part not tight enough. To remedy this, one should insist on a tightly fitting detachable lining being provided, which is laced on to the stump first; two laces attached to the lower end of it are passed

into the bucket and out through holes at the bottom; then, as the stump is introduced into the bucket, these laces are pulled upon firmly and draw the stump evenly in, soft parts and all, ensuring a good and comfortable fit.

The Weight.—This is of importance. The missing portion of the patient's limb may weigh from 5 to 15 pounds, and if we give him a very light limb in place of it, he has great difficulty in controlling it. The weight should be approximately a couple of pounds less than what has been lost. On the other hand, a very heavy limb is a great handicap. If the weight is not enough, it can be increased by putting some lead weights into the lower part of the free space of the bucket, or into the hollow of the business part.

Method of Ordering.—We can either leave the whole affair to the instrument-maker—the worst plan—or allow him to confer with us—the best method—or we can order it ourselves. Sometimes the latter course is necessary when the patient is in an out-of-the-way district, and cannot be got up to town. A tracing is made on a large sheet of paper of the sound limb and of the stump, together with the measurement in inches of the circumference of each every 2 inches up. If the maker prefers it, plaster casts may be sent as well. In the case of the lower limb, a boot of the affected side should accompany the order, and the line of the knee-joint should be indicated on the tracing, together with the circumference of the waist.

CHAPTER XI

MISCELLANEOUS CONDITIONS AFFECTING THE FEET AND HANDS

1. Foot-Drop.

This may occur in any debilitated patient who from some cause or other has to lie on his back, and cannot turn to lie on his side. In such circumstances the weight of the bed-clothes, or even the weight of the feet alone, is quite enough to cause it. In any wound of the foot, especially on the dorsum—*e.g.*, a scald—the patient soon finds, if left to himself, that movement hurts, and that the only way to avoid it is by letting the foot drop. In fracture of the leg-bones exactly the same thing happens. In injuries to the sciatic and external popliteal nerves, and in infantile paralysis, dropped foot is often the patient's most prominent symptom.

Whatever the cause, the first step in treatment is to keep the foot up by some splint or apparatus. For efficiency, comfort to the patient, elegance, and durability, the "right-angled tin night-shoe" (Fig. 1) has no equal. Where a Thomas's knee bed-splint is being worn, this night-shoe is not required, a very simple attachment to the splint being used instead (see Appendix, Fig. 54). If the dropped foot is due to some nerve or muscle injury which may take a long time to recover, or may never recover at all, it will be necessary to give the patient an artificial muscle to wear during the day to enable him to walk in comfort. This is known as a "walking instrument, single to the knee, with uplifting toe-spring." It is fitted to the patient's ordinary boot or shoe (see also p. 42).

When a foot has been "dropped" for some time untreated, the tendo Achillis becomes contracted, and it is then very difficult to bring the foot up to a right angle, even when the knee is bent to relax the gastrocnemius. Sometimes the splint will accomplish this; but if the foot cannot be brought forcibly to that angle by the surgeon's hands when he examines it, it is almost certain that the tendo Achillis will require lengthening by operation (see p. 5).

In attempting to bring a dropped foot into the right-angled position, whether by a splint, or, as some prefer, by weekly wrenchings and applications of plaster of Paris bandages, care must be taken not to produce a pressure sore beneath the ball of the big toe, for this is where the pressure falls.

2. Corns and Contracted Toes.

(See also Congenital Deformities of Fingers and Toes.)

Measures for the treatment of this often extremely painful affection are divided into two groups: (1) Those which get rid of the corns; and (2) those which prevent their recurrence. The ordinary treatment for a painful corn is to cut it down as much as possible, without causing bleeding, either straight away, or after preliminary soaking with hot water or some chemical, and then for a few days apply some protective dressing, such as a corn-plaster or lint and strapping, until the pain and tenderness have gone out of it. The patient resumes his ordinary vocation entirely relieved, but after a few weeks or months the corn reappears as before, and treatment is required again. Such merely palliative treatment should only be practised in the slighter cases; in all others we should aim at *curing* the corn—*i.e.*, removing it, and preventing its recurrence.

1. **To Get Rid of the Corn.**—The foot is soaked in hot water (105° F.) for half an hour; the hard part of the corn is rubbed gently away with a file, and glacial acetic applied to its base. It is then covered with indiarubber sheeting of the same quality as that used by dentists in making a

rubber dam (glove rubber is not thick enough), fixed in position by two elastic bands around the foot or toe, one distal and one proximal to the corn. This is removed morning and evening, and the acid reapplied for two or three days until the site of the corn begins to feel tender, when application of the acid is stopped and the rubber covering used alone. By this time the corn, with the immediately surrounding skin, is white and dead-looking; after another two days, if not before, the core of it can be removed completely by rubbing firmly with a gauze swab. The rubber is left off altogether, and lint spread with boric ointment applied and reapplied twice daily for two or three days more. The surrounding parts soon regain their normal appearance. For this treatment to be effective the patient should not use the foot while it is being applied. If the corn is inflamed, the inflammation must be entirely relieved by fomentations and rest in bed before this treatment can be carried out.

2. **To Prevent its Recurrence.**—To do this one must remove the causes producing it, the two commonest being a contracted state of the toes and incorrect footwear. A condition frequently met with is where the toe is hyper-extended at the metatarso-phalangeal joint, and flexed at the proximal interphalangeal joint; this deformity, when exaggerated, as it often is in the case of the second digit, is known as "hammer-toe." The result of this is a corn on the sole of the foot beneath the head of the metatarsal, and another on the dorsum of the toe over the prominent inter-phalangeal joint. No amount of treatment directed to the region of the corn will prevent its recurrence if the contracted state of the toes be not remedied. The extensor tendons of each contracted toe must be divided subcutaneously with a fine sharp-pointed tenotome; in a severe case it may be necessary to divide the flexor tendons too. Thereafter the toes must be prevented from contracting again by gentle passive stretching morning and evening. If there be present an actual condition of "hammer-toe," it must be dealt with by operation.

Where the patient will not submit to an operation a circular felt corn-plaster, with a hole punched out of the centre for the corn to fit into, is often very useful for protecting it from pressure.

Having got the toes straight, and having removed the corns, it is essential that the patient be fitted with boots the shape of his feet. These should be made to measure on fresh lasts by a surgical-bootmaker. When one foot is $\frac{1}{4}$ inch or $\frac{1}{2}$ inch longer or wider than the other, a ready-made pair cannot possibly be satisfactory. Boots and shoes as ordinarily worn by the majority of people are too narrow in the tread, causing excessive pressure at certain points, and consequently corns. Socks and stockings, too, are all made the same shape for the right and left foot, and if tight assist in cramping the feet and producing corns. Some centuries hence hosiers will get them made shaped for the right and left foot, and many foot troubles will cease to exist.

Soft Corns.—These occur on the sides of the toes and in the clefts between them, where two skin surfaces are closely opposed. To cure them, the feet must be washed twice daily, dried very thoroughly, especially between the toes, powder dusted into the clefts, and dry stockings put on. They are not due to pressure, but to excessive moisture and consequent maceration of the skin. Putting cotton-wool between the toes increases the perspiration and aggravates the condition. Mention may be made of a common trouble, sores between the toes. They get quite well if treated in the same way, by frequent drying and dusting with powder; application of ointments, which increase the moisture, is contra-indicated.

Operation for Hammer-Toe.—The lump which sticks up, consisting of the joint formed by the head of the proximal and base of the middle phalanx, is excised through an elliptical incision made on the dorsum of the toe, with its long axis parallel to the latter. The ellipse includes the corn. The extensor tendon expansion is split longitudinally, and the two lateral halves retracted, exposing the

joint; with a sharp pair of bone-cutting forceps the bones are cut through, the plane of the first cut being at right angles to the plane of the second, and removed. The toe is then easily brought straight, the cut surfaces of the bones fitting against each other, and eventually becoming united. The operation is completed by three or four silkworm gut sutures. The aim of the operation is to get a short, straight toe, stiff, but cornless.

In a very severe case, amputation of the toe is preferable to excision of the prominent joint; the level of the amputation should be through the centre of the shaft of the proximal phalanx; never remove the base of this, as its absence will cause undue pressure to fall on the head of the metatarsal bone.

Note.—Do not try and excise the joint through a transverse incision; it makes the operation very difficult, and gives no better result.

3. Pes Cavus (Claw-Foot).

This has to be distinguished from congenital and paralytic club-foot.

It is an acquired deformity, usually bilateral, whose cause is unknown, characterised by progressive shortening of the extensor tendons of the toes, the tendo Achillis, and the plantar fascia, producing respectively hyperextension of the metatarso-phalangeal joints, dropped foot, and exaggerated arch, with the result that the patient cannot put his foot properly to the ground, but tends instead to walk chiefly on the balls of the toes, with the production of painful corns beneath them. The boots get quickly out of shape, with the soles worn away under the balls of the toes; walking becomes very painful.

The condition can, as a rule, be relieved almost entirely by operation, and the patient enabled to walk quite comfortably. A few severe cases cannot be relieved sufficiently, and must be treated on palliative lines. To test if the case is a suitable one for operation, the surgeon takes each foot

in his hands and tries whether firmly pressing up the ball of the big toe will temporarily relieve the deformity; if it does, operation is indicated; if the deformity cannot be reduced in this manner, operation will only relieve imperfectly.

Under anæsthesia, a tenotomy is done of the five extensor tendons opposite the heads of the metatarsals, and of the plantar fascia where it is tense under the skin; the tendo Achillis is lengthened, and the foot and toes wrenched into their best possible position, and placed in a right-angled tin night-shoe with slots. These slots are cut in the sole-piece to coincide with the clefts between the toes, and tapes are passed through them and over the toes to pull these down flat. The splint is kept on day and night for a week, and then left off during the day to allow the patient to begin to walk; at night it is replaced. Every day after the operation the foot and toes are gently manipulated into the best position. After a month of such treatment a practical cure is obtained. The patient must now be fitted with fresh boots, as his feet are longer than before; if still allowed to wear his former boots, a relapse is certain.

The night-shoe should be worn at night for six months, and the patient examined at intervals to observe that cure is maintained.

Note.—The plantar fascia should not be excised by open operation; such excision may lead to the formation of much scar tissue, with subsequent contraction worse than before.

4. Hallux Valgus.

This often extremely painful deformity is almost universal amongst adult civilised peoples. The majority of cases are due to wearing shoes and stockings wrongly shaped, with the end or point opposite the third toe instead of the first, so that the latter is pushed out into the hallux valgus position all the time they are worn. If the shoes and stockings are too small the trouble is aggravated still more. In a

growing child this state of affairs rapidly produces distortion of the bones forming the big toe-joint.

It may also follow crushing fractures of these bones. It is a common complication of flat-foot, though it is difficult to decide always whether it causes it, is caused by it, or merely accompanies it. Another condition which may complicate it is metatarsalgia (plantar neuralgia), in which the anterior transverse arch of the foot becomes flattened out. The deformity may consist of:

1. Simple abduction of big toe at metatarso-phalangeal joint, easily replaceable by gentle pressure.

2. The same, but not replaceable.

3. Abduction and partial lateral dislocation of the base of the phalanx off the head of the metatarsal bone, as a rule only partly reducible.

4. Any one of the three preceding conditions, with a bony lump or exostosis projecting inwards from the head of the metatarsal bone.

5. Any one of the four preceding conditions, with a corn or callosity over the most prominent portion of the joint, beneath which corn there may be a bursa, forming the condition known as bunion. Sometimes there is a bursa, but no corn, and sometimes the corn or bursa is inflamed or suppurating, the latter communicating perhaps with the joint cavity. Even when it does not communicate, and where there is no bursa, the joint itself is nearly always the seat of some inflammation.

Treatment.—The treatment of a slight case consists in wearing a rubber "toe-divider" between the first and second toes, or in wearing stockings with a separate division for the big toe, and in either case having properly-shaped boots and shoes. It must be borne in mind that a rubber "toe-divider" makes the foot broader, and this must be allowed for by wearing a wider-fitting boot. The stockings with separate division for big toe work well if the patient's skin will stand it; unfortunately, the machine has not yet been devised for making these stockings without a seam—though it could be easily done—and the ridges in the stock-

ing are apt to cause blisters. A "toe-divider" in a bad case only pushes the other toes out of position, and makes the trouble worse. In a marked case, where the "toe-divider" is not satisfactory, a good result may be sometimes obtained by operation; the tendon of the abductor hallucis is transplanted from the under to the inner surface of the base of the proximal phalanx, and retained there with fine silk or linen thread, the toe being kept in line by a pad of gauze pressed in between it and the next one, and retained there for two months, during which time the patient must not walk. This operation is no good at all when moderate pressure cannot replace the toe in line.

When there is a bony lump which is quite clear of the ground when the patient is standing it should be chiselled off, using a sharp flat chisel and a wooden mallet.

When there is a lateral dislocation which cannot be reduced (two radiograms will decide this point), that part of the head of the metatarsal bone which should articulate with the base of the phalanx, but does not, must be cut right off. When this is done, the articular cartilage covering this bony fragment may be found eroded from the constant irritation to which it has been subjected, and this accounts for much of the pain which has been experienced.

If there be a corn over the lump, its presence should be ignored unless it be very large, when it must be got rid of first by suitable treatment. If there is a bursa under the corn—that is, if the condition of bunion be present—it should not be removed or interfered with at operation unless it also is very large, when a small portion of its wall may be cut away to hasten absorption.

When there is inflammation or suppuration, *prolonged treatment* by rest in bed and fomentations is indicated before any curative operation may be attempted. There is no more distressing condition both for patient and surgeon than profuse suppuration following an operation to cure a hallux valgus. When no operation is possible, or where the patient declines it, a shield of thin leather is worn over the projecting part to protect it from the pressure of the shoe, and the

latter must be wide, without a toe-cap, and of some soft leather. The prominence of the big-toe joint may be made less noticeable by hollowing out or sinking the part of the sole beneath it.

Remarks.—I used to advise excision of the corn and bursa at the same time as the removal of bone, but I found that this often involved the removal of valuable tissue, and I have

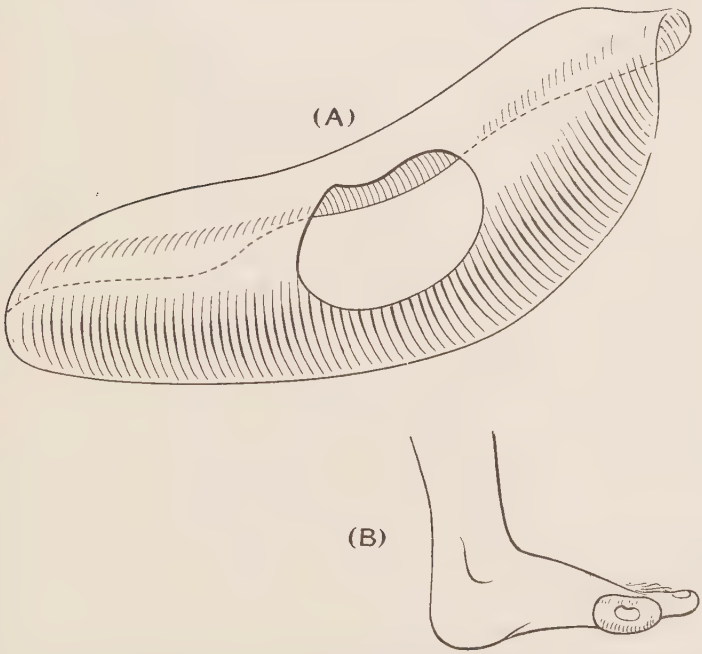


FIG. 52.—LEATHER SHIELD FOR HALLUX VALGUS (FISCHER'S).
A. Actual size. B. Applied to foot.

come to the conclusion that it is better to leave these alone, subject to the exception already mentioned. During the days of convalescence, all redundant tissue rapidly absorbs in a really remarkable manner, leaving only enough to form a sound protective pad over the artificially flattened bone.

The stitches of horsehair are removed on the eighth day, and massage, consisting of stroking, kneading, and friction

movements, started on the day following. On the tenth day the patient is allowed up in a chair, and encouraged to put her foot to the ground, and to take a few steps on her heel; in a very few days she is able to bear her full weight on the foot. In a month to six weeks the patient is able to resume her occupation, provided that she has a pair of comfortable boots. Where no tendon transplant has been done, small pad of gauze or cotton wool should be inserted between the big toe and the next one, to help keep in the former; this must be changed daily.

The relief of pain caused by this operation is often extraordinary; it may not give a cosmetic success, but the functional result is splendid.

I should like to refer to certain methods of treatment which should be given up. These are the use of mechanical springs applied to the inner border of the foot to adduct the toe, and the operations of excising the head of the first metatarsal bone or of cuneiform osteotomy of its neck. The springs do not produce the expected result, and if made slight enough to be worn with comfort in the boot, are not strong enough to keep the toe adducted. The operation of cuneiform resection of the neck of the bone is nearly always unsatisfactory, and the patient is not in the end improved. The operation of removal of the head of the bone is so often followed by crippling of the patient for life that I cannot think a few successes entitle it to be considered at all. When one realises that the bone removed forms the main inner support of the anterior arch, and the main anterior support of the longitudinal arch, one will not be surprised at deplorable sequelæ.

Hallux Rigidus.—This is a progressive stiffening of the first metatarso-phalangeal joint, accompanied by considerable pain. It is due to rheumatoid arthritis, and seems almost impossible to cure or even arrest. All that can be done is to protect the joint from irritation by wearing easy shoes of soft leather, and to place a transverse bar of indiarubber $\frac{1}{4}$ inch thick across the sole just behind the joint, so that in walking the pressure is taken off it, and

distributed farther back in the foot. Massage, baths, and a warm, dry climate are generally found to ease the pain, and sulphur in homœopathic doses has been recommended.

5. Plantar Neuralgia (Morton's Metatarsalgia).

This is a painful affection of the front part of the foot, increased by pressure, usually localised around the fourth metatarso-phalangeal joint. By T. G. Morton, who first described the condition in 1876, the trouble was thought to be due to a nipping of the branches of the digital nerves between the heads of the fourth and fifth metatarsal bones. Others, however, ascribe the symptoms to crushing of the nerves between the head of the fourth metatarsal and the ground. Whatever be the actual anatomical basis for the pain, there is no doubt that cramping of the foot in a thin-soled boot too narrow in the tread is the usual cause of it, and that it is aggravated by long-continued or oft-repeated pressure, such as that caused by stirrups in riding, or by the clutch or brake pedals in motor-car driving.

The pain may only come on occasionally, and last momentarily; or it may be almost constantly present, so that the patient cannot bear the pressure of his boot, and continually has to sit down every few hundred yards to pull it off to ease his foot. (The pain is exactly similar to that caused in the hand by a very powerful handshake.)

The condition often accompanies contracted and hammer toes, and corns may be present.

Treatment consists in wearing boots with thick soles the shape of the feet, and plenty wide enough in the tread to avoid crowding of the toes and front parts of the feet. A transverse indiarubber bar is placed across underneath the sole, just behind the heads of the metatarsal bones, as in treating hallux rigidus. In the severe cases, where these measures give no relief, even after the toes have been straightened and the corns removed, the head of the fourth metatarsal bone must be excised through a small

dorsal incision in line with the shaft of the bone. The extensor tendon is split into two lateral halves, which are held aside, and the neck of the bone divided with bone-cutting forceps. After three weeks the patient is allowed to walk in properly-shaped boots fitted with the transverse bar.

6. Painful Heels.

There are at least four conditions which may cause pain around the heel:

1. Chronic irritation of the skin over the insertion of the tendo Achillis from badly-fitting shoes.
2. Inflammation of the bursa between the tendo Achillis and the os calcis.
3. The presence of a bony spur in the attachment of the long plantar ligament to the os calcis.
4. A partial separation of the posterior epiphysis of the os calcis, occurring in children.

(1) A lump, often very tender, is found over the lower part of the tendo Achillis, looking exactly as if the skin has been pushed out by a lump in the bone. A radiogram, however, shows the bone normal. The lump is a thickening of the skin caused by the constant irritation of shoes with stiff backs to them which do not grasp the heel properly, but slip up and down. Treatment is, first, by rest and fomentations, if the lump be tender, then by wearing slippers without backs, and finally by wearing boots with soft backs to them which reach up well past the irritated area.

(2) Inflammation of the bursa is usually produced by a long walk up and down hills in someone out of training; the unaccustomed rubbing of the tendon over the bone inflames the bursa, which has not time to hypertrophy. Treatment consists in a few days' rest, followed by short walks on the level, long walks being avoided for some time.

(3) Pain is felt under the heel in the sole of the foot when the patient walks much, especially on hard ground. A radiogram shows the presence of a bony spur projecting

forwards for $\frac{1}{4}$ inch or $\frac{1}{2}$ inch from the inner tuberosity of the os calcis. Treatment should be protective—less walking; a rubber disc beneath the boot-heel; a piece of sponge rubber beneath the patient's heel, inside the boot; the patient walking on the toes, with heels just clear of the ground. Probably the symptoms are due to bruising of the periosteum around the spur, and they pass away if the feet are rested and protected.

I have not seen any benefit follow removal of the bony spur by operation. (It may be noted that some writers ascribe the presence of the spur to an attack of gonorrhœa.)

(4) This condition, which is known as *apophysitis* of os calcis, always occurs in children, and is characterised by slight persistent limp, inability to walk far because of pain, tenderness about the posterior aspect of the heel low down, localised in front of the tendo Achillis on either side, which symptoms have persisted for some months. A radiogram shows an abnormal gap between the body of the os calcis and the posterior epiphysis, with signs of inflammatory reaction. A similar condition occurring in the tubercle of the tibia is known as "Schlatter's disease." Treatment consists in keeping the child off its feet for a month or longer, after which, all the symptoms having vanished, it is allowed to get about again gradually.

7. Rupture of Extensor Tendon of Finger.

This is a quite common accident, causing the terminal joint of the finger to be semiflexed, much to the annoyance and hindrance of the owner. Treatment should be, not by straightening the finger to bring, as one would think, the separated portions of the tendon together, but by the paradoxical plan of flexing the proximal interphalangeal joint, and extending the distal, which is done with a small wire splint. Owing to the arrangement of the "dorsal expansion," this position is the one which really brings about apposition of the severed tissues. The splint should be kept on for two to three weeks.

8. Duputyren's Contraction of Palmar Fascia.

In middle-aged and elderly people a contraction of this fascia may set in, gradually progressing, and terminating by dragging down the ring and little fingers into the palm of the hand. It has been attributed to rheumatism, pressure of a walking-stick, fibrositis, etc., but the cause is not known. The hand becomes severely crippled, and the contracted fingers catch on the patient's clothing and cause him much pain and annoyance. The skin of the palm becomes so closely incorporated with the fascia that excision of the latter, which would seem the best treatment, becomes quite impossible. It is better to treat the condition by several tenotomies; the tight bands are divided with a fine tenotome wherever they stand out under the skin, and the fingers gradually uncurled forcibly until they lie nearly flat. Though relapse is common, it can be largely prevented by subsequent massage and movements over a prolonged period.

CHAPTER XII

THE TREATMENT OF OLD GUNSHOT INJURIES

It is only possible in the small space available to give a general idea of the commoner of these, considering them under the following headings:

1. Adherent scars.
2. Persistent sinuses and ulcers.
3. Cavities in bone.
4. Contractures.
5. Stiff joints.
6. Permanent shortening.

Amputation stumps and nerve injuries have already been dealt with; the treatment of malunited and ununited fractures is outside the scope of this book.

1. Adherent Scars.

When a gunshot wound heals, it usually leaves a scar adherent to the structures lying beneath. Many of these adherent scars give rise to no trouble, and are best left alone. A considerable number, however, cause painful symptoms and hamper the patient, as where the skin is adherent to the calf muscles. A few of these painful cases may improve sufficiently under massage to render an operation needless, but in the majority the scar will have to be excised, and the gap made good. This is done by undercutting the edges of the skin on either side until it is possible to slide two lateral flaps together without tension. If there be tension, it is probable that the skin will slough, and that the last state of the patient will be no better than the first. Particularly is this likely to happen when the

skin is adherent to a bone, such as the shaft of the tibia. At the end of the operation a rubber drain should be always inserted to guard against the formation of a hæmatoma; this is removed after two days. Operation must not be entered upon lightly; one cannot guarantee it will relieve the patient, but only state that very probably it will do so. Where there is obviously not enough skin to make flaps, and where the scar is firmly adherent to a subcutaneous bone like the tibia, operation is contra-indicated: it will only result in failure. It might be thought that the scar could be excised and the gap filled with a graft; but the resulting scar is not much better than the one excised, and is still adherent to the structures beneath. The fear of sepsis must ever be before the operator. If sufficient time is not allowed to elapse between the sound healing of the gunshot wound and the operation, profuse sepsis may be set up by it, which ruins the result. A good arbitrary limit is three months. Where possible, one should cover over the structure to which the skin adhered, muscle or bone, with a layer of fascia dissected up from each side, so that something shall intervene between the previously adherent structures. An exam le of where this can be done easily is in deep scars of the front of the thigh adherent to the femur; the fascia lata is dissected clear on either side and sutured over the muscle and bone before closing the skin wound.

2. Persistent Sinuses and Ulcers.

Where sinuses persist, the cause must be discovered. Often this is a small foreign body, a fragment of shrapnel or bullet-casing, or an unabsorbed ligature from some previous operation. If the sinus leads to dead bone a small sequestrum may be present. In all cases the sinus must be explored with a probe, and a radiogram taken with the probe *in situ*. On removing the cause, the sinus will close, provided it be laid well open, scraped, and packed with gauze, and only allowed to heal from the bottom. Sometimes a scar breaks down, forming an ulcer. Treatment

consists in rest to the part; if situated on the lower limb, this will mean rest in bed. Various applications may have to be made to it before the one which suits it is discovered. There is no one treatment for such an ulcer. I always begin with plain hot water fomentations, and if not successful try double strength saline solution, or weak boracic acid, or eusol, red lotion, flavine, or glucose, ointments such as zinc and benzoin, boracic acid, vaseline. Usually one of these proves successful. Sometimes, if rest in bed does not seem to be doing any good, letting the patient get up and walk about will start the healing process—the congestion produced acting beneficially. Yet I have not found Bier's passive congestion the slightest use in any of these cases; and exposure to the X rays and to sunlight have both proved worthless. Excision of the ulcer may be tried, so as to remove the heaped-up edges, and allow normal epithelium to grow in from the circumference.

After the ulcer has healed, the greatest care must be taken to guard against it being knocked or scratched, otherwise in a day or two it may be as bad as ever.

3. Cavities in Bone.

Where there are large cavities which discharge profusely and show no sign of closing, careful radiograms should be taken to see if any sequestra be present; sometimes a "buried" sequestrum will be revealed, lying in the medullary centre of the bone inches away from the site of the cavity. Treatment in all these cases is the same: a pretty severe operation must be done through a long incision which lays bare the bone above and below the cavity. The latter is completely opened up, considerable bone being removed with hammer and chisel, until its sides no longer overhang, but are widely open; any sequestra present are removed, and after the whole of the exposed bony surfaces have been scraped smooth and clean, they are packed tightly with gauze, which is changed daily. Slowly the cavity then heals from the bottom.

Too often these cavities are tinkered with every few months by blind scraping with a spoon, without any benefit to the patient. Cases have been recorded where the cavities have been successfully filled with flaps of muscle or fat.

4. Contractures.

These are due usually to insufficiently skilled treatment. In many cases they may be overcome by massage and movements, by hot air and whirlpool baths, and by carefully applied splints; but in some a division of the contracted muscles will also be required.

A few special sites may be mentioned.

Tendo Achillis.—See Foot-drop.

Hamstrings.—The patient is put to bed, and a Thomas's knee bed-splint applied. If after three days of combined extension and tight bandaging of the knee to the splint no improvement is obtained, the hamstrings must be divided by open operation, and the knee brought as straight as it will go, the splint being reapplied to complete the process. The operation is done through two 3-inch long incisions, one on either side of the popliteal space; the tendons of the sartorius, gracilis, semi-tendinosus, and semi-membranosus are each seized in turn and divided through the inner incision; while through the outer the biceps tendon is cut through, great care being taken not to injure the external popliteal nerve. Occasionally it may be necessary to divide the tendo Achillis before the knee will come quite straight.

Flexors of Elbow.—When there is contraction of these, the weight of the limb will gradually overcome it in course of time; but the progress of the case may be hastened by carrying a weight in the hand.

Extensors of Elbow.—This is a much more serious condition, for gravity is tending all the time to maintain and even increase the contracture. Fortunately, in most cases the elbow can be bent to a certain extent, and, provided the patient will persevere, treatment by means of Thomas's sling will overcome the condition eventually. The sling

is tightened every few days, and the wrist slowly brought nearer and nearer to the neck until the elbow can be flexed completely, but the process may be a painful and arduous one for the patient. I have never had to divide the triceps.

Flexors of Wrist.—Contractures of these can be cured usually by passive movements and the application of a dorsiflexed wrist splint, which at first is used with the angle flattened out; as improvement comes, the splint is gradually bent until the normal angle is reached.

5. Stiff Joints.

Many joints remain permanently stiff after gunshot wounds, or at least have their movements much restricted. We are sure, however, to be consulted for many years to come by the owners of stiff joints to know if we can do anything to loosen them. A radiographic examination should form the first step in treatment to obtain as much information about the joint surfaces as possible. If they are shown to be normal, or nearly so, we can go ahead and advise certain treatment; but if, on the other hand, the articular cartilage is shown to be missing, or there be considerable bony union between the bones forming the articulation, it is unlikely that the joint will function normally even if the bones are separated. Where there is no joint left at all, all reparative treatment is clearly out of the question. In deciding what cases are suitable and what are not suitable for treatment, often only prolonged experience can form a sound opinion.

Treatment.—When it is clear that the stiffness or limitation of movement must be due to fibrous adhesions between the bones, an anæsthetic should be given—not gas, because with it the anæsthetist cannot guarantee complete or continuous relaxation—and the joint movements carefully examined. When one finds, for example, that there is a slight range of movement in the direction of flexion and extension, one gently but firmly tries to increase this forcibly, feeling one's way, as it were. Usually, as one

proceeds the adhesions give way audibly one by one, until the full range of movement is obtainable. Sometimes at the start the joint is rigidly fixed in the flexed position at right angles, and all attempts at straightening it with moderate force fail. To get over this apparent impasse a simple manœuvre is used, which consists in forcibly flexing the joint still further; an adhesion gives way, and then, when one tries to extend the joint, all difficulties seem removed, and the adhesions give way one by one in the normal manner. The same plan is useful when we are trying to flex a joint and experience difficulty—first try the effect of extending it. After one has obtained all the movement possible, using moderate force, and taking plenty of time over it, the joint is fixed in the new position, which has been rendered possible, before the patient wakes from the anæsthetic. After the manipulation there will be some swelling and pain in the joint (traumatic synovitis), and it must be kept at rest in the new position until this subsides, which takes a week or ten days. On being allowed to use the joint, the patient will find that the range of movement is largely increased. If one is not satisfied that the result is all that can be expected, another anæsthetic should be given two to three weeks later, and the same procedure repeated. It is well to warn the patient that two anæsthetics may be necessary. *This breaking through of adhesions is never to be attempted when any signs of inflammation are present in the joint.* If they are present, all such treatment should be postponed until at least three months from the time of their complete disappearance. If a joint is known to have been affected with suppuration, it should not be forcibly manipulated until a year has elapsed. Even after a year there is a slight risk of setting up acute inflammation, and this risk must be put clearly to the patient, and his consent to manipulation knowingly obtained.

When the skin is adherent to the bone, it may not be safe to manipulate the joint, because of the danger of tearing the skin across—*e.g.*, in the case of an elbow fixed in complete extension, where the skin is adherent to the

olecranon. In such a case a preliminary operation must be attempted to free the skin.

When the elbow has become firmly ankylosed by bone in the extended position, or the knee in the flexed position, there is nothing for it but to excise the respective joints, fixing the elbow in a Thomas's sling at 45 degrees, and the knee in a Thomas's knee bed-splint at 170 degrees. If the right amount of bone is removed, a movable joint will be obtained in the former, and an ankylosed one in the latter.

One word as to the patella; when this is partially ankylosed to the femur, it may be detached by a sharp lateral blow from a wooden mallet without any damage to the skin.

6. **Permanent Shortening.**

Shortening of the lower limb frequently follows compound fracture of the femur. It may vary from ½ inch to 6 inches in amount. A severe limp results unless the shortening be made up in some manner. Three methods are at one's disposal: the introduction of a cork sole, perhaps inches thick, between the upper and the leather sole of the boot; the use of a cork elevator beneath the heel inside the boot, to allow room for which the boot has to be specially made; and the application of a patten to an ordinary boot.

The first method is the one usually employed; it is light, and has the advantage of allowing the foot to occupy its normal position relative to the ground.

The second method has the great advantage of being entirely hidden by the patient's trousers; he walks on extreme tiptoe, however, like a lady in very high-heeled shoes, and the position is a tiring one.

The third method is the simplest and cheapest (a patten only costs 4s. 6d.), but many patients utterly refuse to make use of it.

APPENDIX

THOMAS'S SPLINTS

Thomas's Knee-Splint.—There are three varieties:

1. Thomas's bed knee-splint (see Fig. 9), the simplest form, consists of a padded ring, which fits snugly up against the top of the thigh all round, and of two gradually converging lateral irons, which pass down from this ring on either side of the limb, and meet together by abruptly bending in towards each other 6 inches beyond the foot.

2. Thomas's walking knee-splint (see Fig. 22).

3. Thomas's calliper knee-splint (see Figs. 8, 13, 54).

1. *Thomas's Bed Knee-Splint.*—The two lateral irons of this splint should be fixed on to the oval ring in such a manner that, after padding, the long diameter of the oval will make with the inner iron an angle of 135 degrees; otherwise it will not be comfortable. Also they should be attached to it slightly in front of its long diameter, so that there is more of the oval behind the irons than in front of them. Thus the splints for the right and left legs will be distinguishable. Before placing the limb in the splint, two "extension" strips of adhesive plaster must be applied to the limb below the knee, and kept in position with a few turns of ordinary bandage; then, when the splint is put on, and the ring is snugly up against the perineum, ischial tuberosity and anterior superior spine, these strips or tapes attached to them are passed once each around the lateral irons and fixed together with a safety-pin over the end of the splint, thus preventing the splint from slipping down or the limb from wriggling out of the splint (Fig. 53). *The splint should never be used without this or*

some other form of extension. Ignorance of this important fact has brought the Thomas's knee-splint into disfavour on countless occasions.

The leather-covered ring of the splint is applied next to the skin; no clothes or extra padding intervene. The leather is well vaselined twice daily; this softens it, and very soon any discomfort felt will vanish, as the leather moulds itself to the patient's body. When the splint has once been applied satisfactorily, it should not be removed again for some weeks. The patient lies with his buttocks on a feather pillow or air or water cushion; if he lie on a hard mattress the back of the ring will cut into him. The lower end of the splint does not lie flat on the bed, but is raised up 6 inches by a metal prop fixed on to the side irons with strapping. If it lie flat on the bed, the patient's heel is pressed upon, and at once the splint becomes uncomfortable and often unbearable. To prevent the foot from dropping, the sides of the prop are carried up 12 inches above the side irons to meet together in an arched foot-piece (Fig. 54); to the top of this foot-piece is tied the end of a 3-inch-wide strip of bandage, which is glued to the sole of the foot. When it is desired to move the ankle-joint the strip is temporarily detached from the foot-piece. This is the most comfortable way of supporting the foot. The limb is supported in the splint by two broad strips of canvas or leather fixed to the side irons with clips, and stretching across from one to the other. One crosses

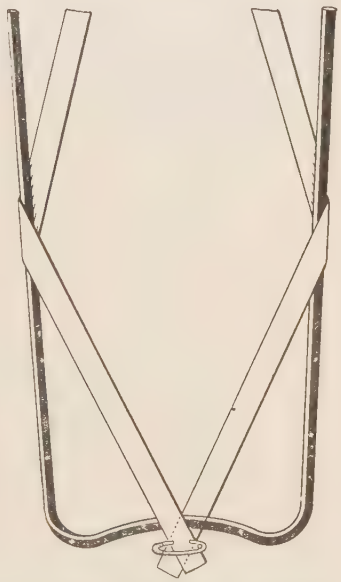


Fig. 53.—Method of fixing "Extension" Strips to End of Thomas's Knee Bed-Splint.

behind the popliteal space, and the other just above the tendo Achillis. A few turns of ordinary bandage fix in position any dressings which may be necessary.

When the splint is being used for the reduction of contraction of the knee, the canvas strips are omitted, and the whole limb is firmly bandaged to the splint with a broad bandage, which encircles limb and splint with each turn, drawing the knee down to it. In a day or two, as the knee extends, the bandage becomes loose, and must be reapplied, while the extension requires to be tightened.

Fracture boards are placed beneath the lower half of the mattress, so as to keep the surface of the bed flat and

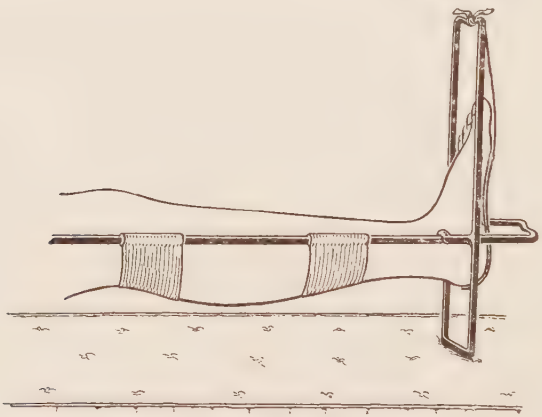


FIG. 54.—COMBINED FOOT-PROP AND FOOT-PIECE FOR USE WITH THOMAS'S KNEE BED-SPLINT (THE EXTENSION STRIPS ARE NOT SHOWN).

Note the method of supporting the foot by a strip of bandage glued to the sole.

allow the splint to lie with the two side irons level. One does not want the splint tilted to one side.

2. *Thomas's Walking Knee-Splint.*—This is 3 inches longer than the limb and being intended for walking on, ends in a patten. The leg is bandaged into this without extension; a patten is applied to the foot of the sound leg, and the patient walks about on crutches, the injured limb extending itself by its own weight. A webbing band fastening with a buckle passes over the opposite shoulder;

and an uplifting toe-spring is added to support the foot if there be any tendency to foot-drop.

3. *Thomas's Calliper Knee-Splint.* — This splint differs from the other two in being practically the same length as the limb. Opposite the centre of the patient's boot-heel the ends of the side irons bend suddenly in at right angles, and fit into each end of a metal tube fixed transversely in the heel (Fig. 55). When the leg is bandaged into this splint most of the weight of the body is taken off by it, while free movements of flexion and extension at the ankle are still allowed. By making the splint $\frac{1}{4}$ inch longer, the patient not putting his foot quite into his boot, but leaving a space between it and his heel, the whole weight of the body may be borne by the splint.

Fig. 55. — Thomas's Calliper Knee-Splint (Left).

Measurements. — State left or right; horizontal circumference of thigh at perineum; length from perineum to centre of boot-heel. Tracing of leg. *Send boot with order*, to have heel tube fitted.

This is an excellent splint for any condition where the leg is too weak to bear the weight of the body, and where some temporary support is required to enable the patient to get about until the limb is strong again—*e.g.*, fracture of femur, or tibia and fibula; rupture of quadriceps, or of crucial or lateral ligaments; fractured patella, etc. When used for such a purpose, it is provided with a kidney-shaped knee-pad (as shown in Fig. 55), the concavity of which is designed to half encircle the patella above, so that the pad presses on the lower end of the femur without touching the patella and causing irritation.

In cases of genu valgum this splint is invaluable. The pad is replaced by a lateral knee-cap, which pulls the knee outwards to the outer iron (see Fig. 8); it again is arranged

not to press on the patella, its two straps passing above and below that bone. When the splint is kept on at night, a soft felt boot, fitted with a heel tube, is worn instead of the walking boot.

If one of the side irons of a Thomas's knee-splint comes too close to the knee, it can be bent out while on the patient by using Thomas's "bend-maker" (Fig. 56). In treating genu valgum, after a time the knee gets pulled out to the outer iron, and can go no farther, unless the latter be bent away from it by using this instrument.

The Thomas's Hip-Splint.—In its simplest form (see Fig. 20) this consists of a flat stem and three curved cross-bands, or

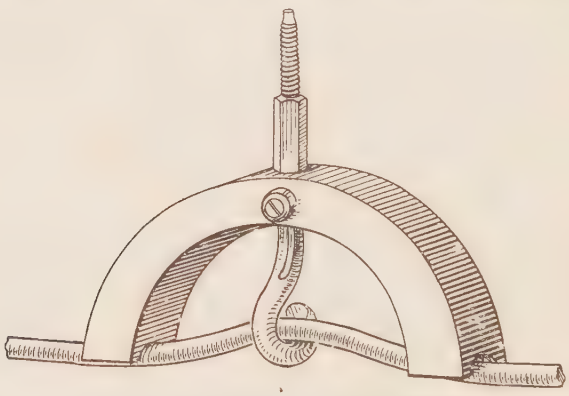


FIG. 56.—THOMAS'S "BEND-MAKER."

wings. These are made of best wrought-iron, which is tenacious, and easily moulded to the shape required—steel will not do, being too elastic. The main stem is long enough to reach from the lower angle of the scapula to the lower third of the leg. A bend is made in the stem at a point opposite the sacrum, and another opposite the gluteal fold, dividing it into three portions—a straight body portion, a slanting buttock portion, and a straight leg portion, the latter following a line parallel but somewhat anterior to the line followed by the body portion.

The upper cross-band is riveted to the upper end of the stem, so that three-fifths will be to the inner and two-fifths

to the outer side of the stem. In each end of this upper cross-band is a hole large enough to pass a piece of bandage through. The second or thigh cross-band is five-sixths of the full circumference of the thigh, and is riveted to the stem just below the second band in the same manner as the first is. The lower or calf cross-band is five-sixths of the circumference of the leg at the junction of the middle and lower thirds, and is joined to the lower end of the stem in the same way. The three cross-bands are the same width as the stem, but half its thickness.

Just above the sacral bend an outward twist of 10 degrees is made in the longitudinal axis of the stem, so that the body portion will lie just to the outer side of the posterior superior spine, while the leg portion will pass down directly posterior to the middle line of the thigh and leg. The inner surface of bands and stem are lined with felt, and the whole covered with basil leather.

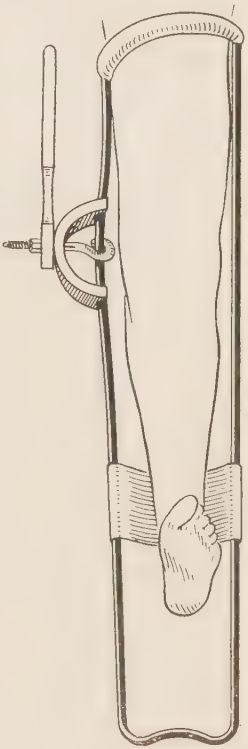


FIG. 56A.—BEND-MAKER APPLIED TO INNER IRON OF SPLINT TO BEND IT AWAY FROM INTERNAL CONDYLE.

The splint is applied by opening out somewhat the wings on the inner side, or the side opposite to that upon which the disease is located, and gently slipping them under the patient as he lies on his back in bed. The wings that were opened out are now drawn closely to the side of the chest, thigh, and leg. The upper cross-band or wings must lie snugly up against the top of the axilla; a strip of broad bandage is looped about the junction of the stem with the upper cross-band, twisted a few turns, and the ends separated, one being brought over each shoulder, passed through the hole at the end of the wing, and tied fast; after each has

been thus tied, they are finally tied together across the front of the chest (Fig. 57). The thigh and leg are fixed firmly to the stem with a broad bandage, it being important to fix the whole of the limb in this way. If the splint fit properly, the slanting buttock portion should follow accurately the slope of the buttock, and when viewed from the side should be just out of sight. There is often a tendency for the stem to slip out from this position—*i.e.*, for the body to slip inwards. This is prevented by the axial twist of the stem. In some cases it is advisable to add an extra half cross-band or wing to the opposite side of the splint, which half encircles the abdomen and prevents this happening; this is known as an "abduction wing" (see Figs. 20 and 57). The stem of the splint must not be moulded to the body. If there is fixed flexion deformity, the patient is bandaged into the splint as well as can be, and a few days allowed for the "fixed flexion" to disappear before the patient settles down comfortably in the splint.

At first the splint is worn in bed; but after a while the surgeon wishes the patient to get up and walk about in the splint with crutches. A patten 3 inches to 4 inches high (see Fig. 21) is fixed to the boot of the sound leg so that the affected leg can be swung clear of the ground.

When the splint has been properly fitted, as for the treatment of tubercular hip, it must not be removed at every visit to the surgeon, nor should the limb be bent and extended, pushed and pulled, twisted and turned, in order to "test the joint." It must be kept immovably applied day and night for months or even years, until all signs of active disease have long disappeared. When this stage has been reached it is not safe to remove it all at once; it should be cut off just above the knee, and the lower cross-band detached and fixed on again to the cut-off end so as to grasp the lower end of the thigh, but allow the knee to be free.

The Double Thomas's Hip-Splint, with Head and Feet Extensions.—This consists of two stems, connected together with cross-pieces, and fitted with a pad for the back of the head and sole plates for the feet to rest against (Fig. 17).

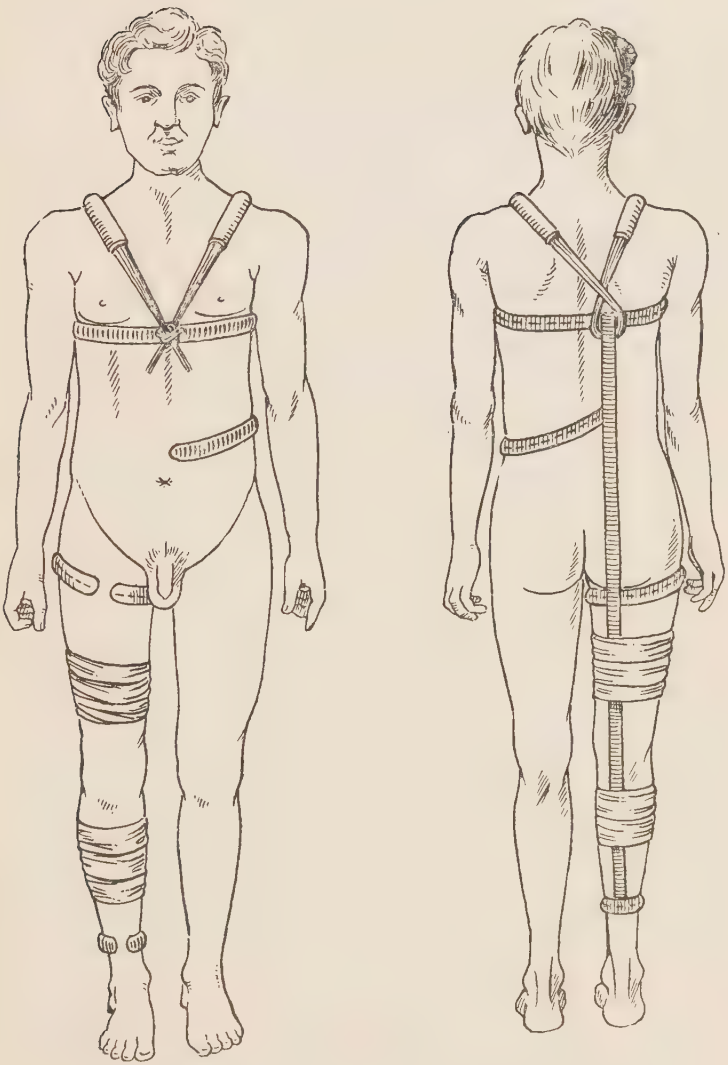


FIG. 57.—THOMAS'S HIP-SPLINT APPLIED.

(From H. O. Thomas's "Contributions to Surgery and Medicine," Part VII., 1890, p. 249.)

The pad and sole plates are adjustable, so as to make the splint longer as the child grows. The child is bandaged into this splint and carried about in the horizontal position like a piece of furniture.

The Thomas's Posterior Spinal Splint.—This consists of two parallel vertical steels, which meet together above and below, moulded to the contour of the spine, and incorporated in a leather back-board (see Fig. 14). The splint extends from the top of the shoulders to the level of the seat of a chair when the patient is sitting—say, from the seventh cervical vertebra to the beginning of the gluteal cleft. It is fixed to the body by a pelvic band, an abdominal band, and by padded groin and axillary straps. The groin straps are attached in front to the pelvic band, which in turn is attached by an anterior vertical strap to the abdominal band, which in its turn is attached by loops to the axillary straps. Thus the different parts of the splint are all connected together and the spine kept immobilised, without, however, interfering in any way with the movements of respiration or digestion. There is a removable lining to this splint; when after three or six months it may have become soiled, a fresh one is put in its place. This splint does not in any way take off the weight of the upper part of the body from the lower part, but fixes the spine, preventing all voluntary movement, and relieving muscular spasm, if this be present, by keeping the spine straight without muscular effort. It is a most useful appliance in convalescing tubercular disease of the spine and in fractures of the lumbar vertebræ, and may often be of service in severe infantile paralysis of the erector spinæ muscles.

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